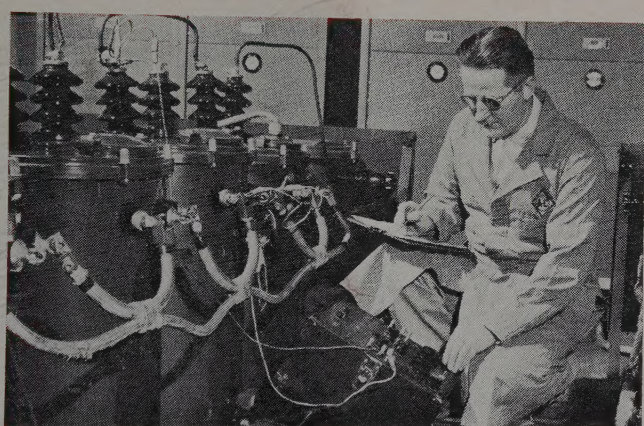
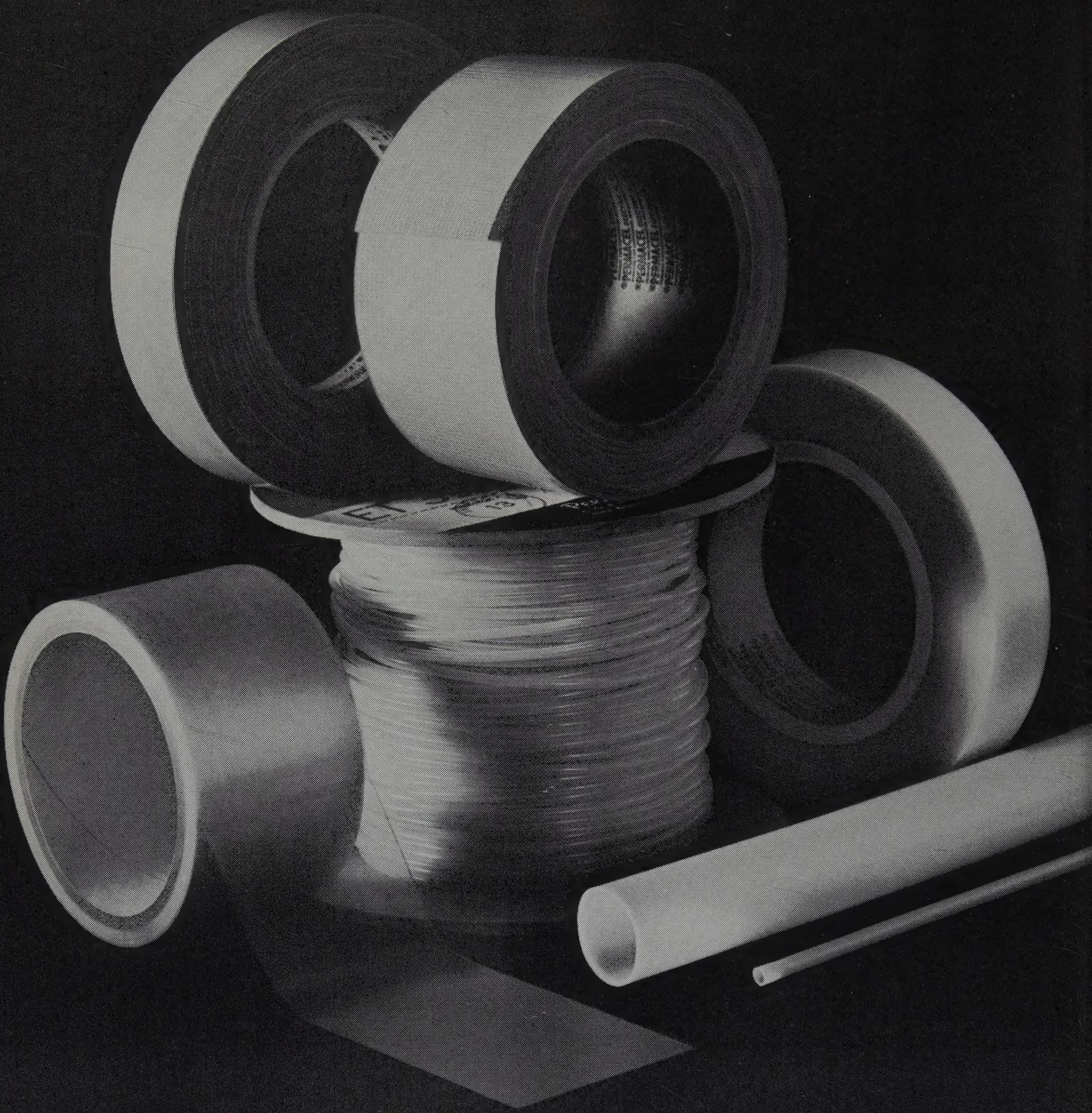
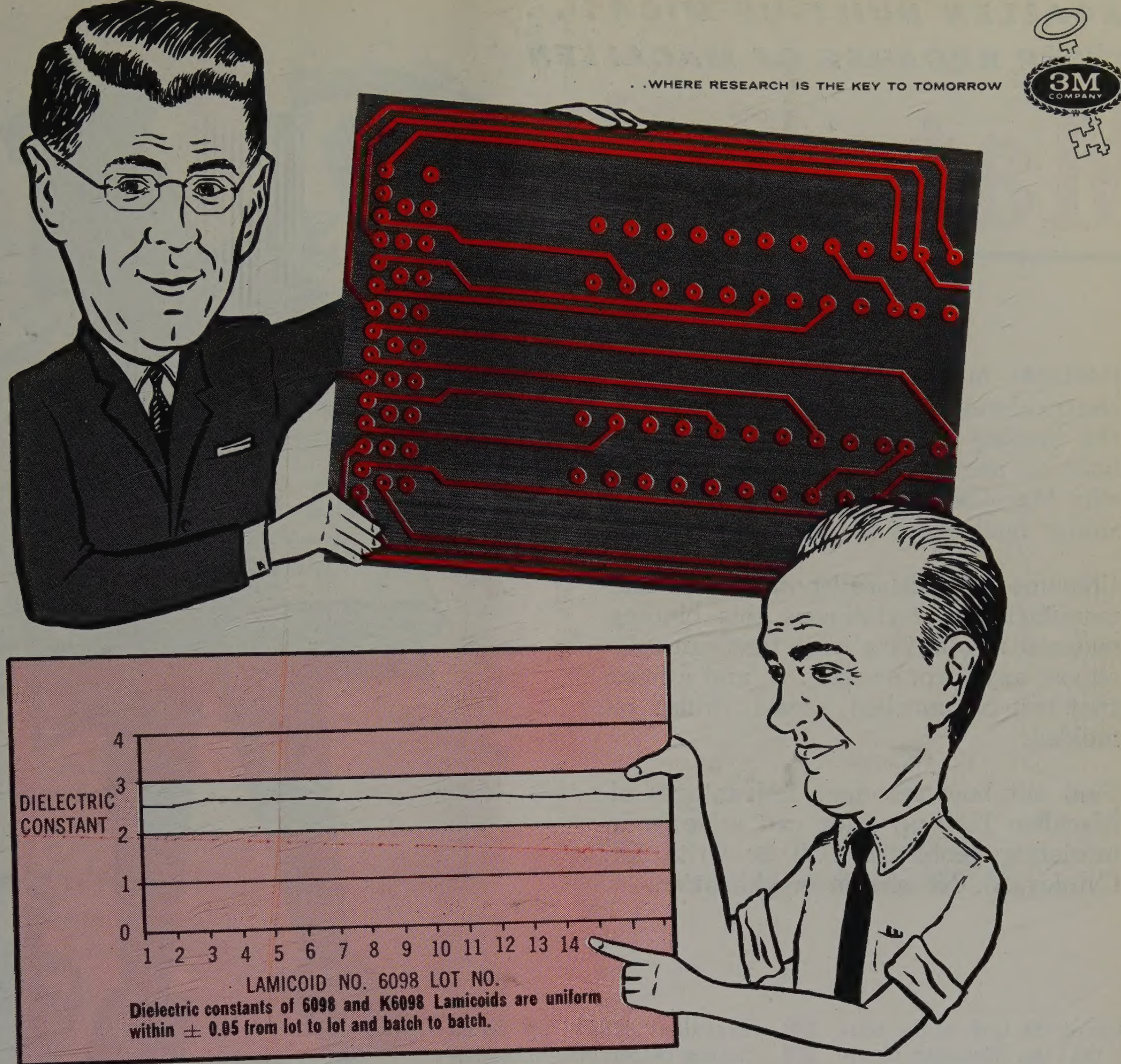
June 1961

Insulation



Transformer insulation . . . page 20





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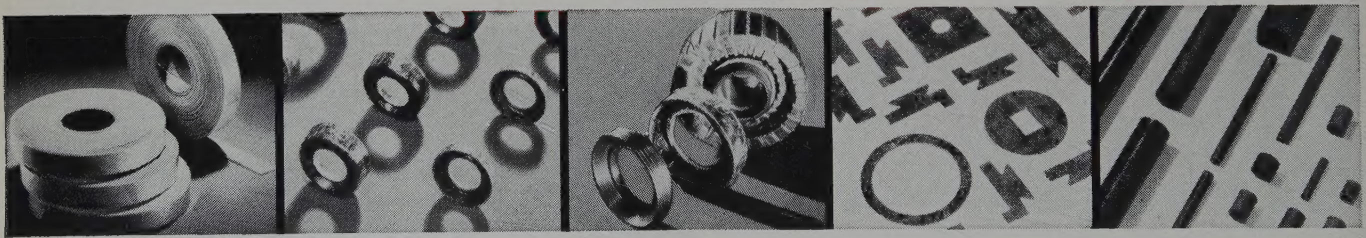

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Insulation

For the Electrical and Electronic Industries

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From the Editor

Opinions and Rambling Thoughts

More on Insulation Education

You'll recall that this column in the April issue was devoted to the need for more and better insulation education. Since that time we've received letters from, or talked with, a good many people who think that this is a matter of vital concern. Some agree with our views. A few disagree. Several feel that insulation education is solely the job of industry via on the job training and that there is little need to even mention the word insulation in our universities. Regardless, better insulation engineers and scientists are required. The way to achieve this is by better insulation education. How better insulation education can be accomplished is a matter of discussion . . . let's keep discussing it until everyone is aware of the problem . . . then let's do something.

As regards discussion and possible action, there are some encouraging signs. For one thing, the American Institute of Electrical Engineers' Committee on Electrical Insulation with its Technical Information Subcommittee and the AIEE Committee on Education are jointly sponsoring a session at the AIEE Summer General Meeting on "Education in Electrical Insulation." The session is slated for the afternoon of June 21 (at Cornell University, Ithaca, N. Y.). Organized by Graham Lee Moses of Westinghouse, the session will include papers describing engineering opportunities in insulation, what the colleges are presently teaching about insulation, the need for insulating material research, industry's outlook on insulation education, and an outline for a proposed course in insulation fundamentals. The subject matter for this AIEE session sounds superb—we hope that the committees involved will consider the possibility of publishing these papers in booklet form and distributing them to our colleges and universities, prospective students, and industry.

Another man with a burning interest in insulation education is E. L. Brancato of the U. S. Naval Research Laboratory. He has been instrumental in work leading to the formation of a committee on education within the Electrical Insulation Conference which is co-sponsored by AIEE and NEMA. Some of the objectives which have been suggested for the committee include the formulation of approaches to the introduction of courses in insulation and dielectrics; initiation of the distribution of conference publications to colleges and universities as a means of encouraging interest in the field of insulation materials and to establish liaison between the conference and the educators; sponsoring of the preparation and publication of appropriate textbooks; and providing of the means of scholarships related to specific problem areas. We heartily endorse the goals of the proposed committee and hope that it will meet with the necessary encouragement, cooperation, and help of the industry.

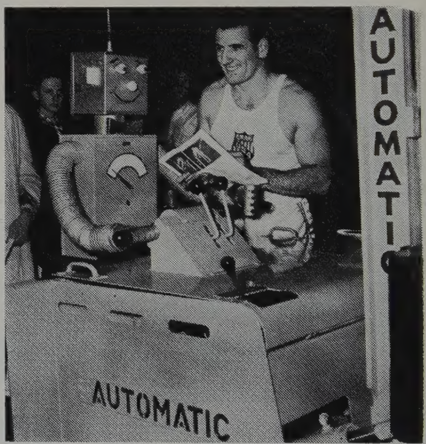
SPI Exposition

As many of you know, the 9th National Plastics Exposition and National Plastics Conference sponsored by the Society of the Plastics Industry are scheduled for the Coliseum and Commodore Hotel, respectively, the week of June 5th. Highlights of these meetings are reviewed on another page. For more extensive coverage, refer to our sister publication, PLASTICS DESIGN & PROCESSING. Since plastics are such an extensive portion of the insulation field, we strongly urge your attendance. This is especially important in view of the fact the exposition is held only once every two and one-half years—the opportunity to see in person what's new in plastic materials, supplies, and equipment will not be presented again until 1963.

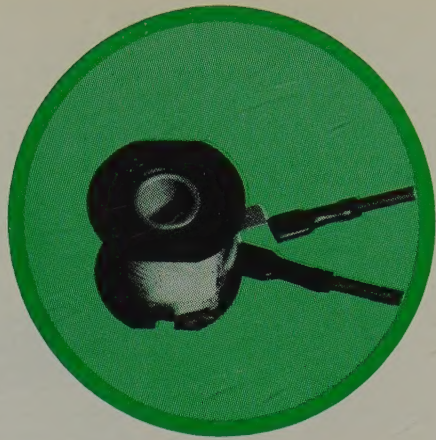
New Developments

According to the National Inventors Council, the U. S. serviceman of the future may wear a servo-assisted power unit, be supported by artillery firing shells with plastic components stronger than steel, and use small arms that are virtually noiseless, flashless, and smokeless. These are some of the inventions the council would like to see developed—if you have any ideas or would like to learn about other needed inventions, write to the National Inventors Council, OTS, U.S. Department of Commerce, Washington 25, D. C.

And probably the most important development is Mr. Otto-Matic, radio-controlled robot who operated the fork-lift truck used to facilitate measurement of the bar in the pole vault event at the annual Chicago Daily News Relays. The gentleman on the

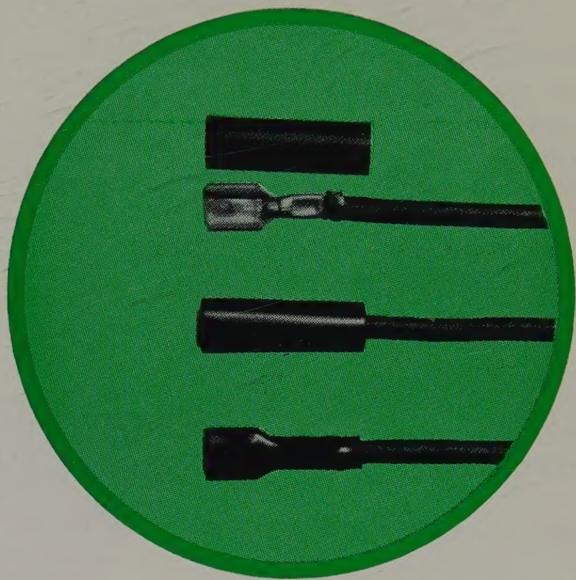


right is Don Bragg, Olympic champion and world record holder for the pole vault event. The robot is important not because of its automation possibilities but because now, when workers get hit by fork-lift trucks, they can look up from the floor and be cheered by the perpetual smile on Mr. Otto-Matic's face—this is much better than human fork-lift truck operators who always wear sardonic sneers of accomplishment when they run over workers and old ladies.



INSULATION FOR SNAP-ON FEMALE DISCONNECTS

1. Thermofit sleeve
2. Disconnect
3. Sleeve positioned
4. After heating



IN 3 SECONDS

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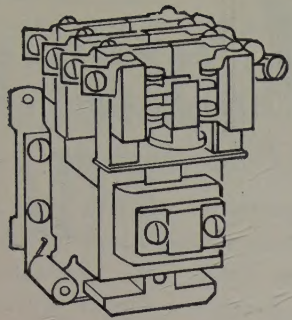
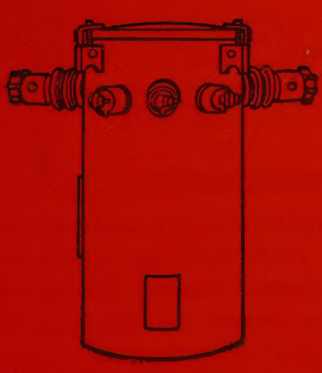




News and Views

Mergers and Acquisitions

One thing the recession did not stop was the merger and acquisition trend—it just keeps rolling merrily along. There are even cases on record where an individual has started a company, merged it with a bigger firm, and then repeated the process two and three times. Some of the latest mergers and acquisitions are as follows:

International Telephone & Telegraph Corp. has agreed to purchase Surprenant Manufacturing Co., a Massachusetts manufacturer of insulated wire and cable. Surprenant reportedly has annual sales of some $17-million. The acquisition will be accomplished by means of an exchange of a new class of cumulative preferred stock.

Loral Electronics Corp. of New York has announced plans to acquire Accurate Specialties Co. Inc. of Hackensack, N.J., producer of ceramics and metals. One share of Loral will be exchanged for each two and one-half shares of Accurate with a total of about 150,000 Loral shares involved in the transaction.

Plans for a merger of The Lionel Corp. and Textron Electronics Inc. have been submitted to the directors of both companies. Tentative terms call for the exchange of one share of Lionel for three and one-third shares of Textron. Sales for the merged corporation, to be operated under the Lionel name, would be around $60-million. The merged company would have 15 plants and about 4500 employees.

Amerace Corp. has offered to purchase for an undisclosed sum of cash Swan Rubber Co. Amerace, with its various divisions, manufactures wire and cable, chemicals, plastic and rubber moldings, and plastic compounds. Swan produces rubber and plastic products.

New Graft Cellulose

Rayonier Inc. has introduced a new industrial raw material resulting from the highly uniform grafting of an organic compound to the cellulose polymer. Tradenamed "Ethylose," the material is seen as the first of a whole family of modified cellulose. Applications are expected in coated papers, coatings, and ceramics.

Business Better But Still Spotty

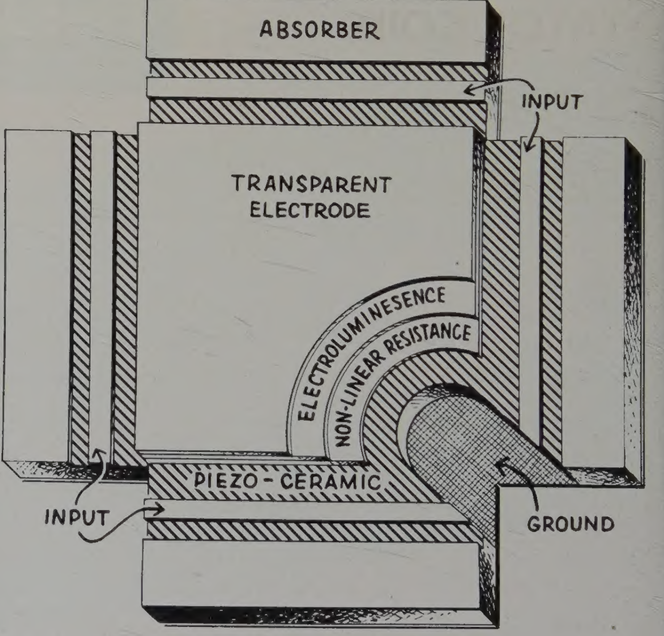
More and more signs point to a gradual business recovery but there are still some indicators which cause worry. In general, most first quarter reports presented total sales figures which were about even or somewhat lower than the equivalent 1960 period . . . but profits, for the most part, were down considerably. With very few exceptions, most company executives are claiming that the second quarter reports will be much improved over the first quarter but there is considerable doubt as to whether the 1960 second quarter will be equalled. Acting as a possible brake on the recovery is the fact that some firms are now cutting back on operating, research, and promotional expenses because of the lower profit margins.

Another Anti-Merger Suit In Wire and Cable Industry

The Justice Department, which a year ago instituted an anti-merger action against Alcoa for its two-year old acquisition of Rome Cable Corp. (scheduled for trial in the fall), has now brought a similar suit against Kaiser Aluminum & Chemical Corp. in an attempt to force Kaiser to divest itself of the wire and cable plant it acquired four years ago from U. S. Rubber Co.

New Piezoelectric-Electroluminescence Display Device

The construction of a new piezoelectric-electroluminescence display device is shown in the schematic diagram. Developed by General Telephone & Electronics Laboratories, Inc., the device is an electronic panel less than one-half inch thick which utilizes a new principle to produce a moving lighted image. One side of the ceramic material is coated with a layer of electroluminescent material. When



voltage pulses are applied to several electrodes on the edges of the piezoelectric panel, traveling acoustical waves are introduced into the ceramic material. Electric fields accompanying these waves interact with the electroluminescent layer to produce a "spot" of illumination on the panel. The position of the spot is controlled by varying the relative timing of the electrical pulses to produce an electronic wave pattern. Light intensity of the spot is modulated by an electric field applied to a transparent conductive layer covering the electroluminescent layer.

ENGLISH ELECTRIC CANADA

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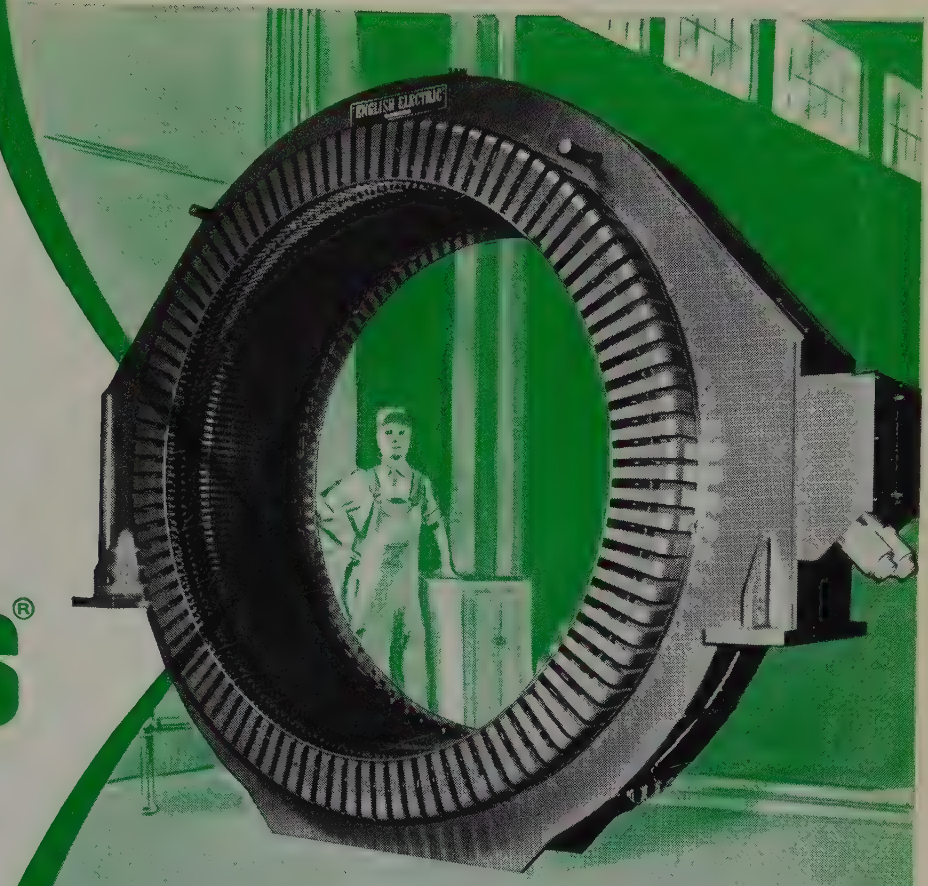

This unit, one of four built by English Electric for export to Europe, is a 4500 HP, 6000 V, 3-phase, 50 cy. synchronous motor stator. Coil ends are taped with Natvar Teraglas, a new flexible insulating material comprising a base fabric woven from polyester (polyethylene terephthalate or "Dacron") warp yarns, and continuous filament glass filler yarns, coated with an improved varnish possessing exceptional dielectric strength under elongation.

English Electric Canada, Toronto, Ontario, Division of John Inglis Co. Ltd. manufacture electrical motors, controls, transformers and switchgear for use in important installations throughout the world.

They have found that Teraglas offers several distinct advantages over the thirsty cotton base tapes formerly used. At no advance in material cost, Teraglas is more readily applied to coils; the higher dielectric strength of Teraglas results in a better insulated coil; and better heat resistance provides a greater safety factor against high operating temperatures due to overloading.

If you are presently using conventional materials, it will pay you to consider the ease of use and extra protection of Teraglas. It is made in four standard thicknesses, .008", .010", .012" and .015", available in sheets, rolls or tapes in black and yellow.

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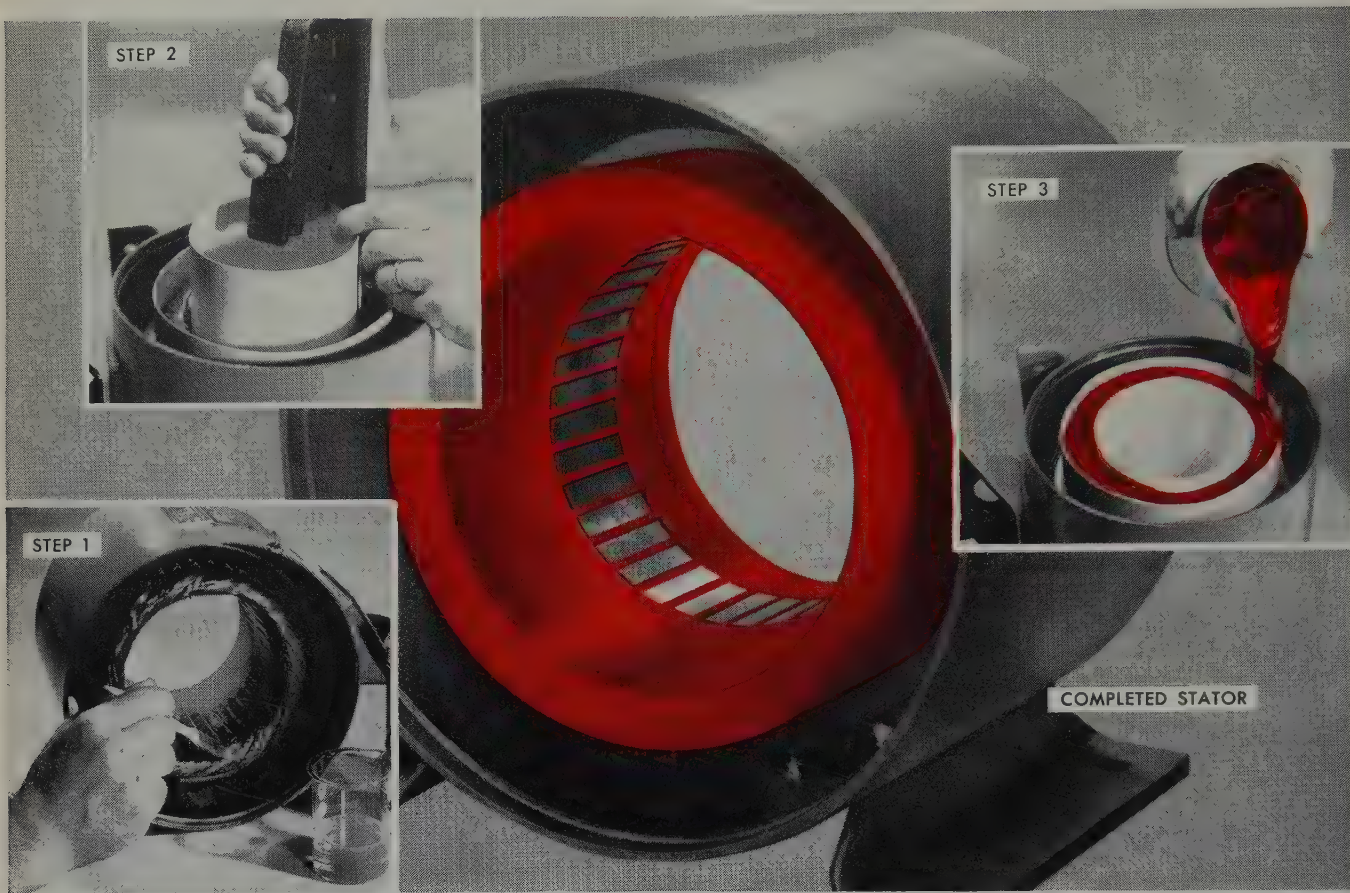
SILICONE NEWS from Dow Corning

Fulltime Protection...



New, Easy-to-Use Silicone Encapsulant Beats Heat, Cold, Moisture, Abrasives

Encapsulating motor end turns with Silastic® RTV, the Dow Corning liquid silicone rubber, produces a clean-cut protective jacket that inspires customer confidence. This confidence is not misplaced . . . the protection is just as effective as the encapsulation suggests.

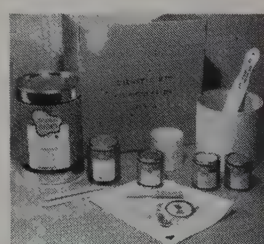
Sure Protection New Silastic RTV especially developed for this purpose pours bubble-free . . . flows smoothly into all crevices . . . and leaves no weakening air holes or thin sections. Setting up, the rubber takes an iron grip on previously primed surfaces, and quickly vulcanizes into a void-free, homogeneous silicone rubber barrier to dust, dirt, moisture, abrasives, many chemicals, and corrosive atmospheres.

When cured, the silicone rubber jacket expands and contracts with windings and laminations . . . will not hairline crack.

For All Motors Equally suitable for Class A, B, F, or H insulation systems, Silastic RTV encapsulation protects against adverse environments and weathering . . . makes costly motor enclosures unnecessary.

Easy Processing Applying the protection is easy and time-saving. Here's all you do—1. paint end turns and lamination surfaces with primer; 2. put simple, easily constructed forms in place; 3. pour catalyzed Silastic RTV over coil end turns. That's all there is to it. The molded jacket cures at room temperature.

Available in Kits
Handy kits containing everything you need for encapsulating motor end turns are available from the Authorized Distributor of Dow Corning silicone materials in your area. Contact him today. He supplies quality silicone materials that offer economical solutions to your pressing insulating problems.



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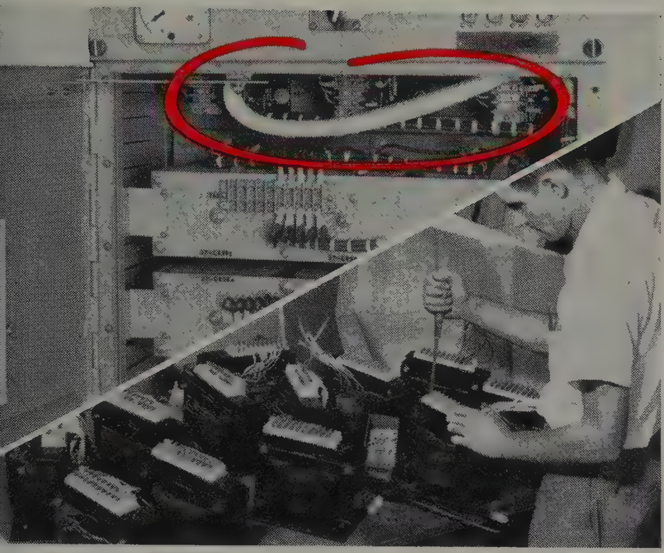

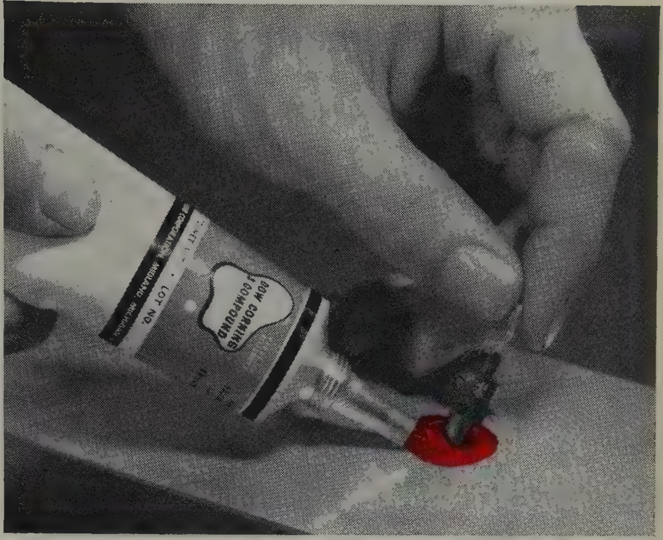

Silicones Pack Power in Small Space

To assure reliability of transformers supplying standby power for submarine nuclear reactors, Milro Controls Company chose silicone insulating components and Dow Corning 997 Varnish.

Reasons for their choice: silicone resin insulation systems provide maximum output for minimum weight, superior resistance to moisture, and ample protection against high ambients and overloads. The impregnating varnish, Dow Corning 997, easily withstands operating temperatures up to 250 C. It provides superior protection against all the well-known enemies of electronic and electrical equipment. Each Milro power supply contains three compact, lightweight transformers.

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Compound Cushions, Conducts Heat

A dab of greaselike Dow Corning 3 Compound provides this diode with a ready-made heat transfer path from diode to washer, washer to chassis. As a heat-sink sealant, 3 Compound improves heat dissipation because of its good thermal conductivity, retains this ability . . . never dries out.

A similar product, Dow Corning 5 Compound, is widely used by semiconductor manufacturers for potting transistors. It retains initial consistency from —75 to 200 C . . . cushions vibration and shock. Completely inert and free of mineral salts, it protects against contaminants . . . blocks welding spatter . . . prevents damage to the wafer or junction . . . assures fewer rejects and helps provide superior performance of the semiconductor device.

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Effects of Radiation on Mica

Although increased interest has developed in recent years in determining the effect of high-level radiation on the properties of materials, very little in the way of systematic results is available for mica. Early studies of the effect of radiation on mica were concerned principally with decay of radioactive material initially present in the mineral. During the past 15 years, data showing the effects of bombardment with various types of

Type of Radiation	Property Studied	Dosage	Results and References
α-Particles			
	Optical Effects	1.5-3.7 x 10^3 —Particles/cm^2	Haloes in brown mica; disappear on heating [1]
		?	10^{18} ions/cm^2 developed in bombardment will cause coloration; color disappears after excessive bombardment. [2]
β-Rays (Electrons)			
	Optical Effects	"Electron Gun" 20 hrs. (no details)	Damage pattern, sinusoidal waveform. [3]
	Electrical Properties	25 millicuries Sr. 90 90 days (15$\mu\mu$ amps/cm^2)	Electrical conductivity unchanged. [4]
		Electrons 5-160 volts in vacuum	Critical speed of 29v. reached; ionization of gases present in mica? [5]
γ-Rays			
	Thermal conductivity	10^7 roentgens	No effect. [6]
	Crystal latice dimension	10^7 roentgens	No effect. [6]
Neutrons			
	Thermal conductivity	0.8 x 10^{20}nvt* epithermal flux; 1.0 x 10^{20}nvt thermal flux.	Thermal conductivity decreases by 30%. [7]
		1.6 x 10^{20}nvt epithermal flux; 2.0 x 10^{20}nvt thermal flux.	Thermal conductivity decreases by 40%. [7]
		0.3-0.6 x 10^{20}nvt epithermal flux; 0.3-0.6 x 10^{21}nvt thermal flux.	Thermal conductivity decreases by 40%. [7]
		2 x 10^{20}nvt	Thermal conductivity decreases by 50%. [8]
	Electrical Conductivity	5 x 10^{18}	Essentially unchanged. [9]
	Capacitance	10^{17}nvt	Very small change. [6]
		10^{18}nvt	±1% change; a few show 5% change. [10]
		10^{14}nvt	470 $\mu\mu$f, 300 vdc showed 0-5% change; 100 $\mu\mu$f, 500 vdc no change. [11]
		10^{18}nvt	Very little change (synthetic mica). [12]
	Dissipation factor	10^{14}nvt	470 $\mu\mu$f, 300v.dc showed 0.01% change; 100 $\mu\mu$f, 500v.dc—no change. [11]
	Density	0.8 x 10^{20}nvt epithermal 1.0 x 10^{20}nvt thermal	Density decrease 2.4%. [7]
		1.6 x 10^{20}nvt epithermal 2.0 x 10^{20} thermal	Density decrease 2.8%. [7]
		0.3-0.6 x 10^{20} epithermal 0.3-0.6 x 10^{20}nvt thermal	Density decrease 3.8%. [7]
	Lattice	2 x 10^{20}nvt	Expansion 1.7% in c-dimension. [8]

** Integrated neutron flux = neutrons/cm² = neutrons/cm² sec. x sec.*
NOTE: In many reactors considerable irradiation by γ-rays takes place incidental to neutron irradiation but the effects cannot be separated.

adiation on certain specific proper-ies of mica have been obtained, but only in the most widely studied case, neutron bombardment, have attempts been made to relate the amount of damage to the total neutron flux. A summary of the results of various studies dealing with the effect of irradiation on certain properties of mica is given in the table, with appropriate reference to the source of data.

From an examination of the data it can be seen that in most of the studies no attempt was made to distinguish the different types of mica with respect to their response to irradiation. Generally speaking, the whole mineral family is found to be relatively resistant to radiation of all kinds. One study shows an effect, observable by the naked eye, of electron bombardment (the total amount of radiation was undesignated), while no measurable effect was produced by γ-rays in the mega-roentgen range. In the case of neutrons essentially no effect was observable with an integrated flux as great as about 10^{19}nvt; irradiation beyond this level produces a gradual decrease in thermal conductivity and density. In several respects, therefore, mica, like most other silicate and oxide crystalline minerals can tolerate much higher radiation levels than various organic materials.

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Pixilated Patents

By Mike Rivise

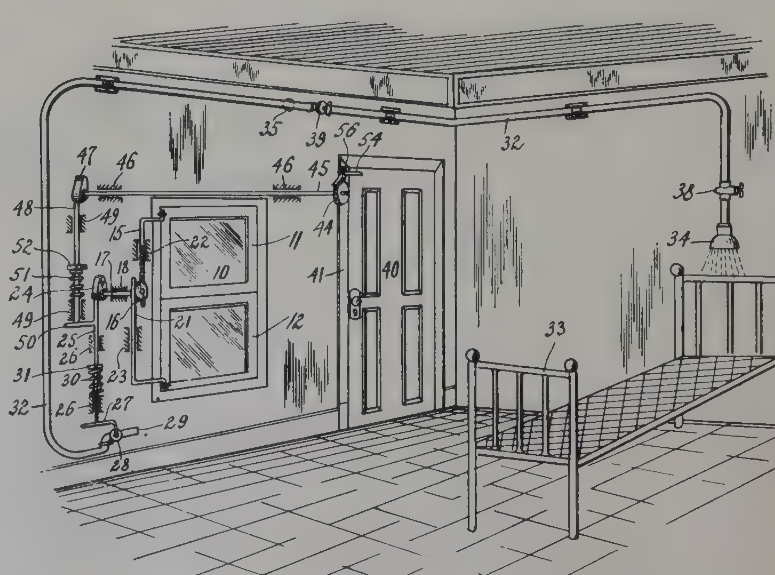
Fifty-fourth in a series of odd and interesting inventions in the electronics field from the files of the U.S. Patent office.

The patent for this month, No. 1,046,533 dated December 10, 1912, admittedly has no connection with the electrical/electronic field except that it was evidently designed to replace the many types of electrically operated burglar alarms which produced an audible warning of some sort such as a bell, whistle, etc. Such systems obviously are not always effective with persons of defective hearing or with sound sleepers.

Anyway, we thought you might enjoy the reasoning of the inventor, Arnold Zukor of New York City, who thought that a shower bath would be a very effective means of waking almost anyone. He envisioned a shower mounted over a bed which was to be operated by an intricate gear system driven by the opening of a door or window. Thus, any unauthorized opening of either doors or windows while the mechanism is set to go would actuate the shower mechanism, dousing the sleeper with a spray of water.

The operation of the device is described in the patent as follows: "To bring the parts of the alarm into their operative positions, first the cocks 38 and 39 are set to open a communication between the faucet 28 and the spray-nozzle 34. The racks 15 and 21 are attached by the wing nuts 14 and 20, respectively, to the upper and lower sashes of the window. The keeper 56 is then disengaged from the projection 55 upon the rack 43, whereby the device is ready for operation. If the sashes of the window are lowered or raised from outside by unauthorized persons, rotation will be imparted to the gear 16 and thus to the shaft 17, whereby the cam 24 will act upon the rod 25, which in turn will repress the operating lever 27 of the faucet 28, causing thereby a flow of water toward and to the spray-nozzle 34. Alarm is thus given. Should the door be opened, the plate 54 will be removed from the projection 55 of the rack 43, permitting thereby the spring 53 to act and to rotate the gear 44. The rotation of the gear 44 causes an angular movement of the cam 47 and a shifting movement of the rods 48 and 25, which result in an opening of the faucet 28."

During the day, or at other times when the house was not to be protected by the alarm, the device could be disconnected. Also, if the house was to be protected while the owner was away or outside the system could be set up to activate a spray nozzle outside the house if any of the doors or windows were opened. The resultant spray of water might indicate to those passing by that there was dirty work going on . . . or that the owner was washing the house or watering his petunias.



European Insulation Report

Ed. Note: *The author of this monthly European report is a well-known insulation expert associated with a large European electrical manufacturer. Although it is necessary that his identity not be revealed at this time, correspondence may be exchanged with him by writing* European Editor, Insulation, Box 270, Libertyville, Ill.

A Contribution to the Knowledge of the Impulse Strength of Paper Insulation

By W. Dieterle in the Bulletin des schweizerischen elektrotechnischen Vereins, Vol. 51, No. 13, July 1960, pp. 637-647. Original title: Beitrag zur Kenntnis der Stossfestigkeit von Isolierpapieren. Dr. W. Dieterle is with Sandoz AG., Basel, Switzerland.

In an earlier work, the author has already covered the use of a less acetylated paper as an electrical insulation material. A paper of notable quality with the trade-name "Isocell" was found at that time to have: a low tan δ, satisfactory thermal resistance, very good impregnability, high insulation resistance, and tan δ and the dielectric constant almost independent of temperature within the important range. All these properties are better than those for present good cable papers.

For examples see figures 1 and 2.

In this new work the impulse strength of these acetylated papers, impregnated with insulation oil, is covered in full. The work is not only a good advertisement, but because of clean test conditions, it is also a general contribution to the knowledge of the influence of the impulse strength of paper insulations.

The author succeeded in showing that the impulse strength, using a 1|50 wave, depends primarily on the air permeability, which is a measure of the paper density, and not only on the specific density of the insulation as is often stated in literature on this subject. The rise of impulse strength with the specific density of the insulation is due to its close connection with the air permeability.

From these results it can be concluded that in the case of the high permeability, i.e., small barrier effect of the layers, the breakdown results approach those of clean oil and the low permeability approaches that of an acetylcellulose film.

An interesting statement is that the impulse strength of acetylized paper decreases with a higher air permeability to lower values as those of non-acetylized paper. Nevertheless, the dielectric constant of the acetylized paper is smaller than that of the normal paper.

In the case of the maintenance of the stator insulation of large generators in use, an abundant discussion continues, which is naturally also found in the literature. Mostly the users of the generators emphasize the usefulness of such measurements and the producers of the windings remain rather critical of these expected results.

At the center of the discussion, the dependence of tan δ on the measuring voltage is once again stated, especially the permissible limits for the acceptance testing of a new winding.

The Significance of Tan δ Measurements In the Testing of Bars of Generator Windings

By K. Edwin in Osterreichische Zeitschrift für Elektrizitätswirtschaft, Vol. 13, No. 10, 1960, pp. 625-632. Original title: Die Bedeutung der Verlustfaktormessung für die Prüfung von Generatorstäben. Dr. K. Edwin is with Osterreichische Draukraftwerke AG, Klagenfurt, Austria.

The author, by means of a theoreti-

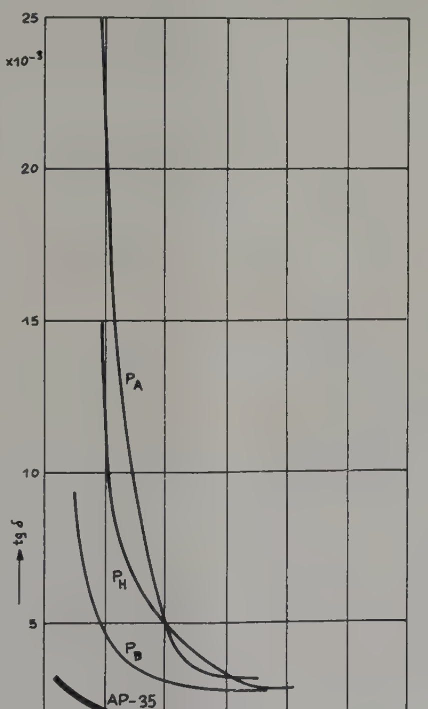


Figure 1, variation of the dielectric loss factor tan δ (50 c/s) of different condenser dielectrics as a function of the drying time t at 110°C. AP-35 = acetylized condenser paper with 35% degree of acetylization.

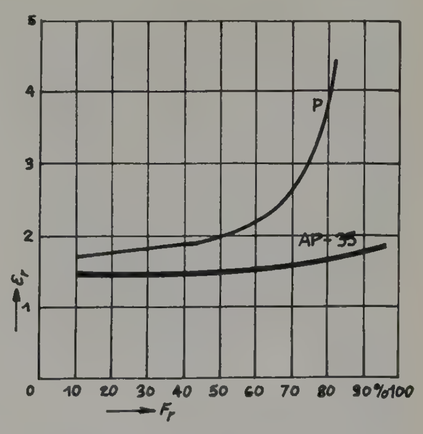


Figure 2, variation of the dielectric constant ε_r (50 c/s) of cable paper (P) and acetylized paper (AP-35) as a function of the relative air humidity F_r, at which the samples were acclimatized.

cal investigation, seeks the answer to the problem about the meaning of the loss factor curve tan δ as a function of the measuring voltage. It is first pointed out that different figures are given as admissible limits, thus preventing standardization. The French and some of the German power companies fix the gradient of $\frac{\tan \delta}{U \max}$ at approximately 1.7 x 10^{-3} per kv, but on the other hand, the manufacturers give values between 2.5 x 10^{-3} and 5 x 10^{-3} per kv as the highest admissible values for the acceptance test of single coil depending on the type of generator.

The author succeeds in drawing up a mathematical relationship of the measured tan δ gradient as a function of the measuring voltage and the volume of air in the insulation. The discussion on the formula gave:

a) The maximum tan δ gradient rises in proportion to the volume of air, given as a percentage of the insulation. An increase in the tan δ gradient of 1 x 10^{-3} per kv corresponds to an increase in the air volume of approximately 1%.

b) The size of the corona onset voltage and the form of the loss curve have no relation to the percentage air volume.

c) The lower the gradient of tan δ, the greater the amount of small air voids in the insulation.

The author considers a low tan δ gradient and is conscious of the fact that low values for a new winding are no guarantee for its behavior in use, if it can not be proved that the insulation does not become higher values in use, i.e., delaminates, which has the effect of creating undesirable air voids.

Romica for Electrical Insulation

By G. Kezdi and Dr. R. Schmid in Micafil Nachrichten, November 1960. Original title: Romica für Elektroisolationen. Dr. R. Schmid and G. Kezdi are with Micafil AG, Zürich 9/48, Switzerland.

The authors describe uses of a mica paper which is produced from natural mica by mechanical means. An important property of mica papers is that in general they are very good from the point of view of ease of impregnation and machineability. As a result they have excellent constant insulation properties. The breakdown voltage of products using mica paper is at least that obtained when using mica splittings.

The unimpregnated Romica has no binder and contains approximately 25% voids by volume so that easy impregnation is certain. The breakdown voltage of Romica papers without any binder or reinforcement is shown in figure 3. However the binder free Romica paper is too weak to be used directly as insulation, i.e., without reinforcement. At present it is mainly used for the following purposes.

a) Fully impregnated flexible tapes, with and without binder.

b) Suction tapes with different reinforcement for continuous tape insulation and impregnation after taping. It has also been possible to use Romica in reinforcing tape using only a very small amount of binder. Using such tapes, continuously insulated conductors can then be impregnated in vacuum using a suitable solvent free synthetic resin (e.g., one of the epoxy resins), and as a result one can obtain high voltage insulation with better properties than mica splittings.

c) Impregnated polymerizable reinforced Romica tapes.

d) Laminates and moldings from hard Micanite.

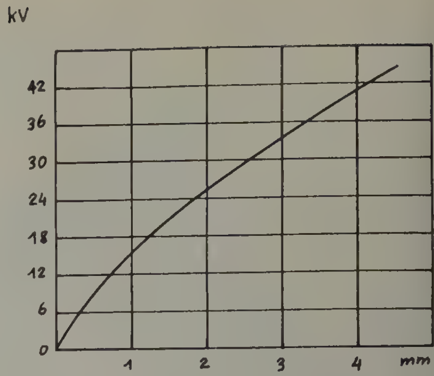


Figure 3, the breakdown voltage (kv) of Romica as a function of thickness (mm) for binder free paper.

Remarks on the Kinetic of the Prebreakdown Process in Solid Insulators

By Prof. Dr. K. W. Böer and Dr. U. Kümmel in "Elektrie," Vol. 14, No. 5, May 1960, pp. 148-152. Original title: Zur Kinetik der Vorprozesse des Durchschlags fester Isolationen.

An investigation into the thermal and field breakdown of a cadmium sulphide crystal. On the application of a voltage potential, the heating of the crystal, which is proportional to the flow of current, was investigated cinematically with the help of the electrothermo-optical effect.

By means of the clear pictures obtained, some of which were published, many interesting observations were made regarding local temperatures, the behavior of the light absorption constant, the optical erection of the breakdown voltage, and the destruction process in the material.

The authors compare these resulting observations with the mechanisms of breakdown in gases and find much similarity in behavior. It seems that the observed, inhomogeneous developments of the field and current flow in a crystal are independent of the electrode form and are the result of intercrystalline effects.

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Temperature Capabilities of a Modern Transformer Insulation System

By W. H. Mutschler, Jr., Chief Engineer, Pittsburgh (Pa.) Works, and W. C. Farneth, Engineer-in-Charge, Development Department, Pittsburgh (Pa.) Works, Allis-Chalmers Mfg. Co.

A major factor limiting the power output of a transformer is its temperature rating. This is determined primarily by the chemical stability and compatibility of the materials used. Since chemical reactions proceed at a rate directly related to temperature, any design changes that reduce this rate will result in longer life expectancy under a given set of operating conditions. An electrical stress above the ionization or corona level will produce higher rates of chemical reaction, resulting in reduced life expectancy.

Since no way has yet been found to produce a thermally inert system, chemical degradation has not been eliminated. When this deterioration has progressed to the point that the system can no longer withstand the operating stresses considered in the design, the transformer fails.

Organic materials in the structure have the lowest chemical stability and are the limiting factor in determining the operating temperature of a transformer. In an oil-filled unit, these materials are the oil, cellulose, and synthetic resins in the form of wire enamel, adhesives, bracing, impregnants, spacers, tubing, etc. Material interactions, the rate of the reaction as a function of temperature, and the products of the reaction will determine the life of the apparatus under a given set of conditions.

Although these are the major reacting materials in the system, it has been found that the lubricants used in the forming of metal parts or protective coatings of metal parts can and do affect the chemical reactions occurring in the system. It is important, therefore, when testing a system of materials to include in the test all the materials present in the apparatus. This is best done, when possible, by testing the actual unit. Tests on a material alone or with a limited number of components can be misleading and result in erroneous conclusions.

Laboratory Investigations

Laboratory tests have determined the chemical interaction of a number of combinations of materials at moderate temperatures. The purpose of these tests was to determine what combination of material would produce a minimized chemical reaction rate, thereby obtaining a more reliable system. This investigation included tests on 9 wire enamels, 17 commercial coating resins, 9 bonding resins, and kraft and manila paper from various sources. Combinations of these materials were tested with copper and steel in proportions typical of distribution transformer construction. Some of the combinations incorporated adsorbents in the system to study their effect on the products of decomposition.

During these tests, a number of characteristics of materials were measured such as dissipation factor, color, dielectric strength, acidity, and IFT (interfacial tension). Of all of these, the acidity of the oil is a particularly sensitive measurement of system stability since acids, however weak, accelerate chemical degradation. Also of interest is the IFT of the oil which is another indicator of stability.

Figure 1 is a tabulation of the acid number and IFT of oil samples in which a number of commercial synthetic coating resins were tested. The test specimens consisted of 20 glass microscope slides coated with a film 15 mils thick which constituted 0.5 percent by weight of the oil in which the resin was to be aged. The coatings were cured as recommended by the supplier, vacuum dried, purged with dry nitrogen, sealed and aged six months at a constant temperature of 105°C. The test apparatus used is shown in figure 2.

Although this temperature is relatively low and although there was no paper included in the system, the acidity of the oil increased very rapidly for all coatings and the IFT decreased correspondingly. Of all the resins tested, the epoxy type F had the least effect on the acidity while the more commonly used alkyd type B had the greatest effect. However, all of the tests indicated significant chemical change. Since these resins are typical of those used on coated layer insulation and since these tests indicated that it would be desirable to eliminate these resins from transformers, it was necessary to develop other means for obtaining the necessary short circuit strength in the units. This was done by improving the mechanical bracing as well as by improving the distribution of turns in the high voltage winding.

Many combinations of paper, steel, wire, oil, and water were aged for one year at 105°C, one year at 120°C and

Test Resin	Aging Time in Months					
	2		4		6	
	Acidity MG-KOH/GM	IFT DYNES/CM	Acidity MG-KOH/GM	IFT DYNES/CM	Acidity MG-KOH/GM	IFT DYNES/CM
Phenolic Type						
A	0.24	17.7	0.48	15.4	0.40	18.6
B	0.10	22.5	0.32	17.0	0.38	11.3
C	0.08	26.0	0.14	22.5	0.22	19.2
D	0.13	18.7	0.11	16.5	0.42	17.3
Alkyd Type						
A	0.10	18.3	0.55	17.1	0.69	17.4
B	0.23	18.5	0.89	16.4	1.30	16.8
Epoxy Type						
A	0.03	21.3	0.09	20.1	0.21	20.8
B	0.03	30.8	0.11	25.9	0.16	17.4
C	0.07	22.3	0.13	20.6	0.15	21.0
D	0.12	19.9	0.21	18.3	0.31	17.2
E	0.22	–	0.12	21.7	0.26	19.2
F	0.03	18.7	0.03	16.5	0.09	20.3
Acrylic Type						
A	0.03	33.3	0.09	25.9	0.24	14.3
B	0.03	31.6	0.06	25.5	0.14	16.1
C	0.05	19.0	0.11	18.7	0.15	16.2
D	0.16	21.5	0.17	19.3	0.22	19.6

Figure 1, effect of synthetic resin coatings on the acid number and interfacial tension (IFT) of transformer oil after aging at 105°C for two, four, and six month periods.

three months at 135°C. Figure 3 is a tabulation of representative samples taken from this series of tests. From the results of these tests it was concluded:

1. That conventional insulating oil will deteriorate even though no other organic materials are interacting with it; that is, the effect of heat alone will cause the oil to become acetic.
2. That synthetic resinous coatings accelerate the degradation of the oil.
3. That the addition of moisture simulating an inadequately dried unit apparently affects the oil as much as it does the paper.
4. Neutralizers can be incorporated which apparently improve the system.

As a result of these tests, investigations were initiated to determine what characteristics would provide an improved oil and to develop more efficient inhibitors.

Recently tests were completed on electrical grade kraft paper with and without amine inhibitors, cyanoethylated kraft paper and other inhibitors under consideration. Figure 4 is a curve of the tensile strength retention of the insulating paper versus time at 225°C for these various systems. As can be seen, no permanent improvement is indicated for any of the systems since they all retain about 20 percent of their initial strength after 100 hours at temperature. However, if the test were short in duration

Figure 2, test apparatus used for aging tests on transformer oil.

Combination of Materials Tested						Aging Temperature and Time					
						105C – 12 Months		120C – 12 Months		135C – 3 Months	
Oil	Copper Iron	Kraft	Coated Kraft	Water	Adsorbent	Tensile Strength Retention Percent	Acidity MG-KOH/GM	Tensile Strength Retention Percent	Acidity MG-KOH/GM	Tensile Strength Retention Percent	Acidity MG-KOH/GM
X						–	.01	–	0.06	–	0.14
X	X					–	–	–	0.03	–	0.21
X	X	X				80	.01	10	0.08	10	0.23
X	X		X			60	0.9 – 1.1	–	–	–	–
X	X			X		–	–	–	0.10	–	0.18
X	X	X		X		–	–	10	0.12	10	0.24
X	X	X			A	–	–	25	0.02	12	0.03
X	X	X			B	–	–	25	0.01	12	0.05

Figure 3, tensile strength retention of kraft paper and oil acidity measurements on systems of materials aged at 105°C, 120°C, and 135°C.

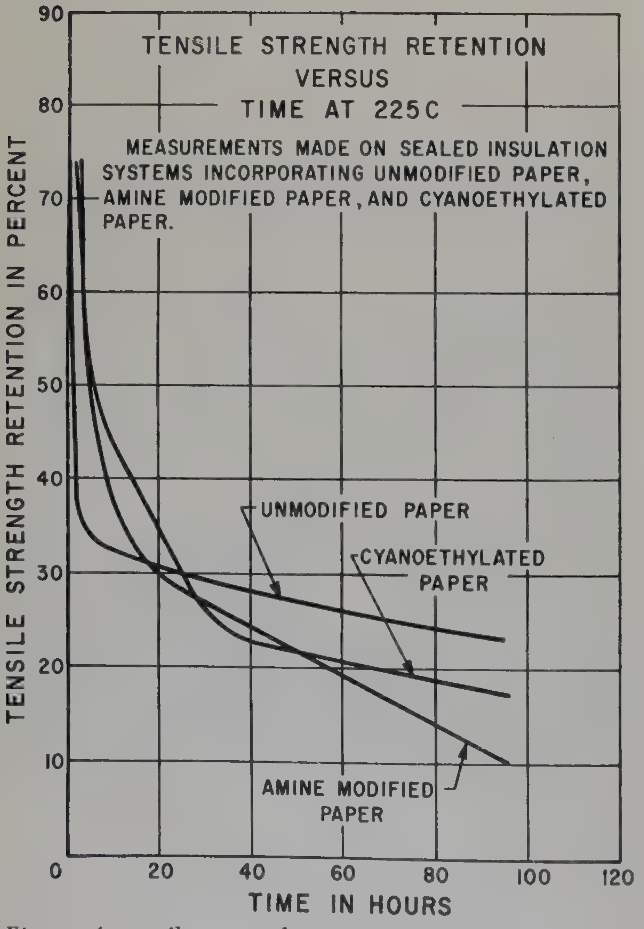

Figure 4, tensile strength retention of insulating paper versus time at 225°C for various systems.

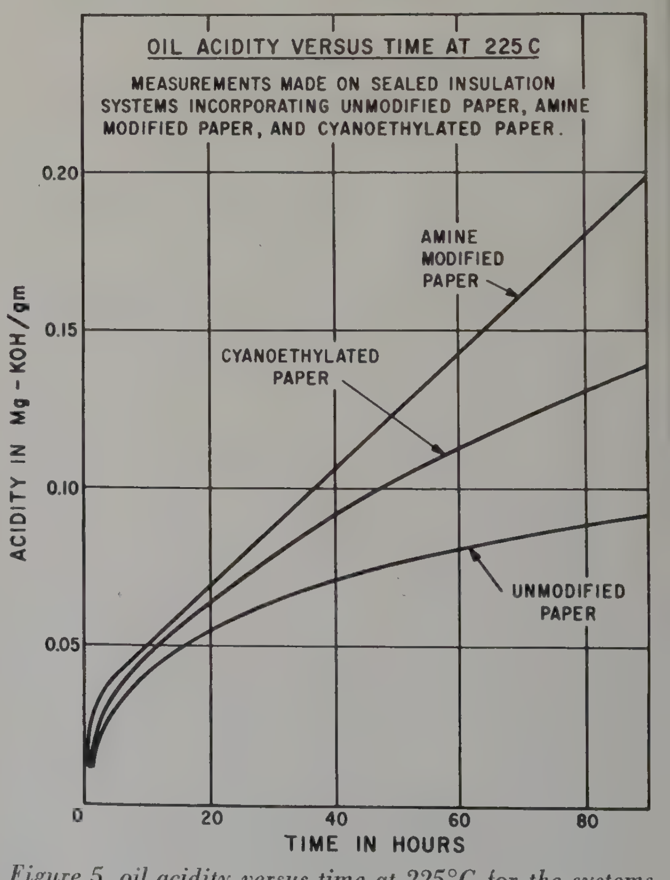

Figure 5, oil acidity versus time at 225°C for the systems charted in figure 4.

one material may appear to be superior to another. It is interesting to note that the 20 percent retention is well above the tensile strength retention reported in units taken to failure by other investigations.[3]

Figure 5 is a curve of acidity versus time for the same three systems. As can be seen, both inhibited systems increase rather rapidly in acidity and although the data is not shown for the other two amines tested, those results also indicated a rapid increase in this characteristic.

Prototype Transformers

Following laboratory tests of the type described, prototype transformers were built and processed in the factory and placed on test in order to substantiate the ability of the most promising system and to determine the effect of oil characteristics while operating at a top oil temperature of 95°C. Figure 6 is a view of the test arrangement of these units and the thermal lagging required to maintain 95°C oil temperature at a predetermined load.

Figures 7 and 8 show acidity and IFT of oil samples taken from three of these units. These curves show that oils which are apparently quite similar when tested in the laboratory do not necessarily perform the same in apparatus. Part of this difference is a result of the constantly changing oil temperature in oven samples, and part is a result of the effect of the manufacturing processes on the system.

As a result of these tests, new standards of performance for transformer oil have been evolved.

Figure 9 is a comparison of oil acidity taken from figure 7 and compared with recently published data describing an almost identical test made by another investigator.[4] The slope of the curves indicates the degree of compatibility of each system.

Production Transformer Tests

In cooperation with other transformer manufacturers through the AIEE Working Group on the Functional Evaluation of Oil Immersed Apparatus, tests on production units were initiated at 220°C and 180°C hot-spot temperatures. The work of this group is still in progress and results have not yet been published.

In addition to the program of the AIEE tests, a program of tests at 140°C was initiated. The results of these tests to date are of considerable interest.

Transformers being tested at this temperature, as shown in figure 10, are connected in series on the low voltage side and shorted. Thermocouples were wound into one unit in order to determine copper hot-spot temperature and oil temperature gradients. These units have been loaded continuously at approximately 200 percent rated load in order to maintain a hot-spot copper temperature of 140°C. Top oil temperature has varied around 115°C depending on the ambient temperature.

Since the tests are being performed in a special brick and concrete laboratory inside a factory building, the ambient air temperature does not vary appreciably. In order to factor in the effect of load cycling, the test units are shut down each Monday and started again Tuesday

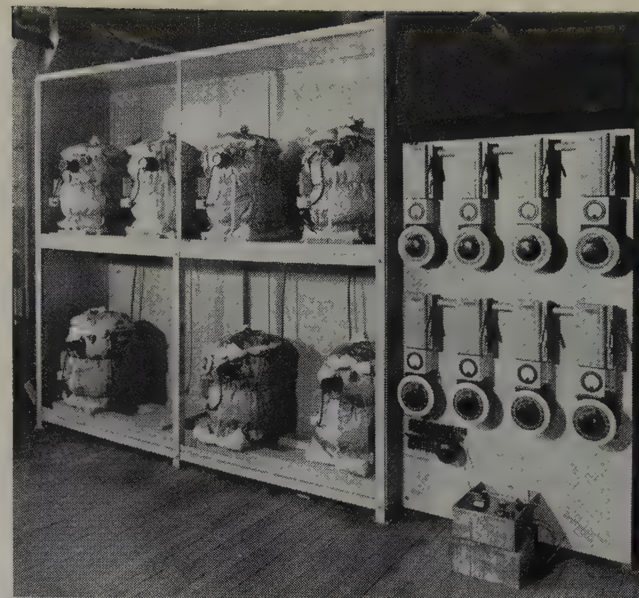

Figure 6, arrangement of prototype transformers used in stability tests at 95°C with eight different insulating oils.

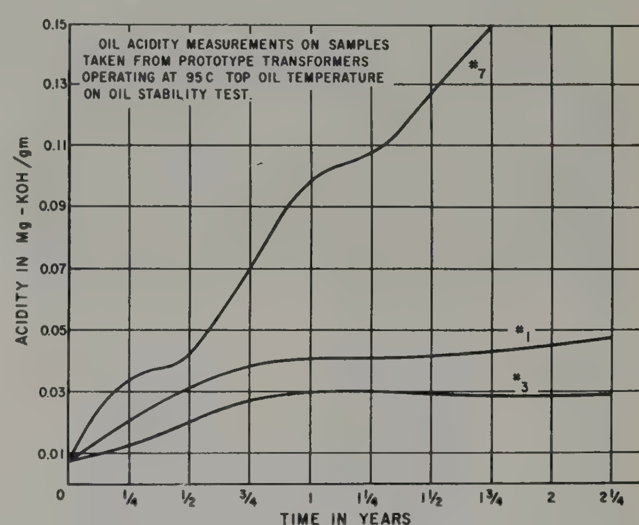

Figure 7, oil acidity measurements on samples taken from prototype transformers operating at 95°C top oil temperature.

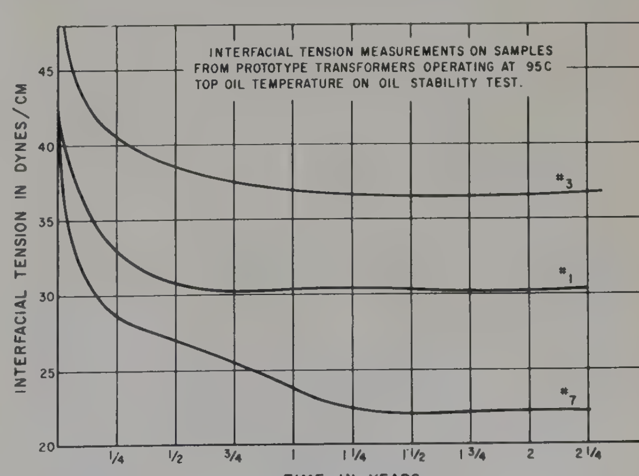

Figure 8, IFT measurements on samples from prototype transformers operating at 95°C top oil temperature.

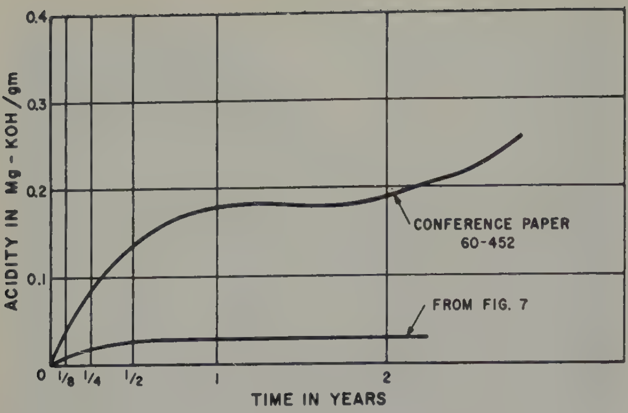

Figure 9, comparison of oil acidity taken from figure 7 and recently published data.

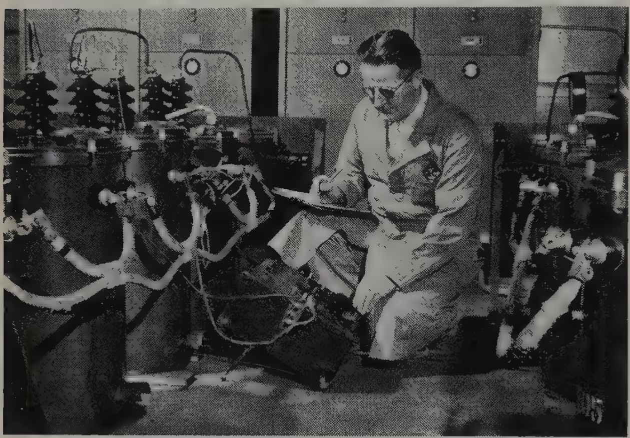

Figure 10, transformer aging test area with 7200 volt distribution transformers operating at 140°C hot-spot temperature.

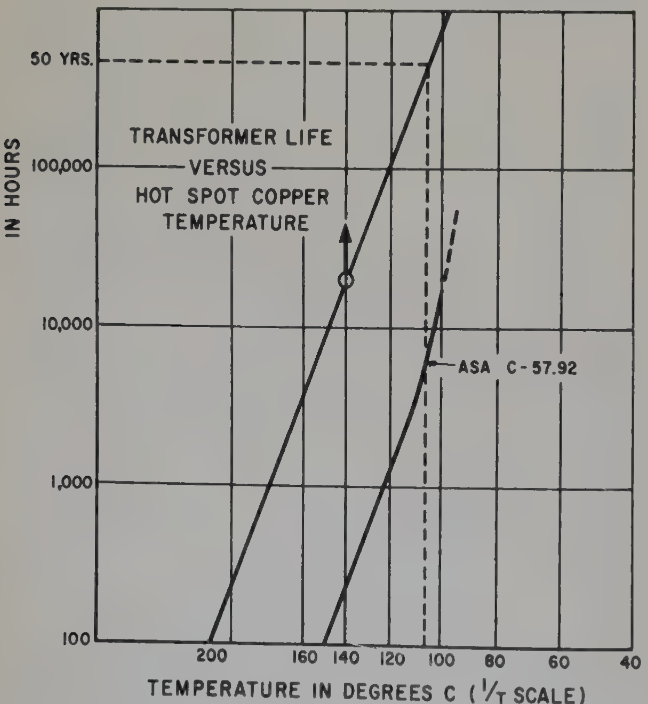

Figure 11, test data taken after 10,000 hours compared with ASA expected life curve.

morning. They are operating 24 hours per day and have been running for over two years. After each 1000 hours at temperature the transformers are subjected to short circuit tests at 15 times normal followed by standard ASA electrical tests at factory test levels. After 20 such tests no indication of distress or disturbance has been noted.

These results are particularly significant since no correlation between mechanical tests on paper and short circuit strength of actual apparatus is necessary. The ability of the system to perform under these conditions is clearly demonstrated.

Oil measurements made after 10,000 hours, however, do give an indication of the general health of the system at this point in the test.

Dielectric Strength	25 kv
Insoluble Sludge	None
Acidity	.16 Mg. KOH per gm
IFT	16.1 Dynes/cm
Moisture Content	50 ppm
Dissipation Factor	.15%

Figure 11 compares this test point with an expected life curve as described by the present ASA guides. Note that at the present standard hot-spot temperature of 105°C, the guides predict a life of approximately 8000 hours or less than one year. A curve through this test point, having the same slope as the ASA curve, would indicate a life of approximately 50 years at 105°C. Based on the data taken at 220°C and 180°C, it appears that this test will continue to run for quite some time.

Conclusions

In summary, this series of tests indicates that:

1. Laboratory tests on small quantities of material, tested at elevated temperatures, are an efficient and quick method for screening new materials or systems. However, data from such tests should be used with extreme caution since these results cannot be reliably extrapolated to operating apparatus. Further, these tests must be made long enough in duration to ensure that conclusive results are obtained.
2. New standards for transformer oil performance were established for higher temperature operation. These standards were evolved through low temperature long time tests.
3. Tests on full size transformers indicate that systems incorporating the least number of materials and materials shown to produce a minimum of acidic byproducts, will have a life expectancy of at least 50 years at a hot-spot temperature of 105°C. Ratings of 65°C average copper rise are now possible and additional revision of the existing loading guides can be effected.

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4. Studies of Insulating Oil in New and Used Transformers, CP 60-452, T. K. Sloat, V. A. Banevicius.

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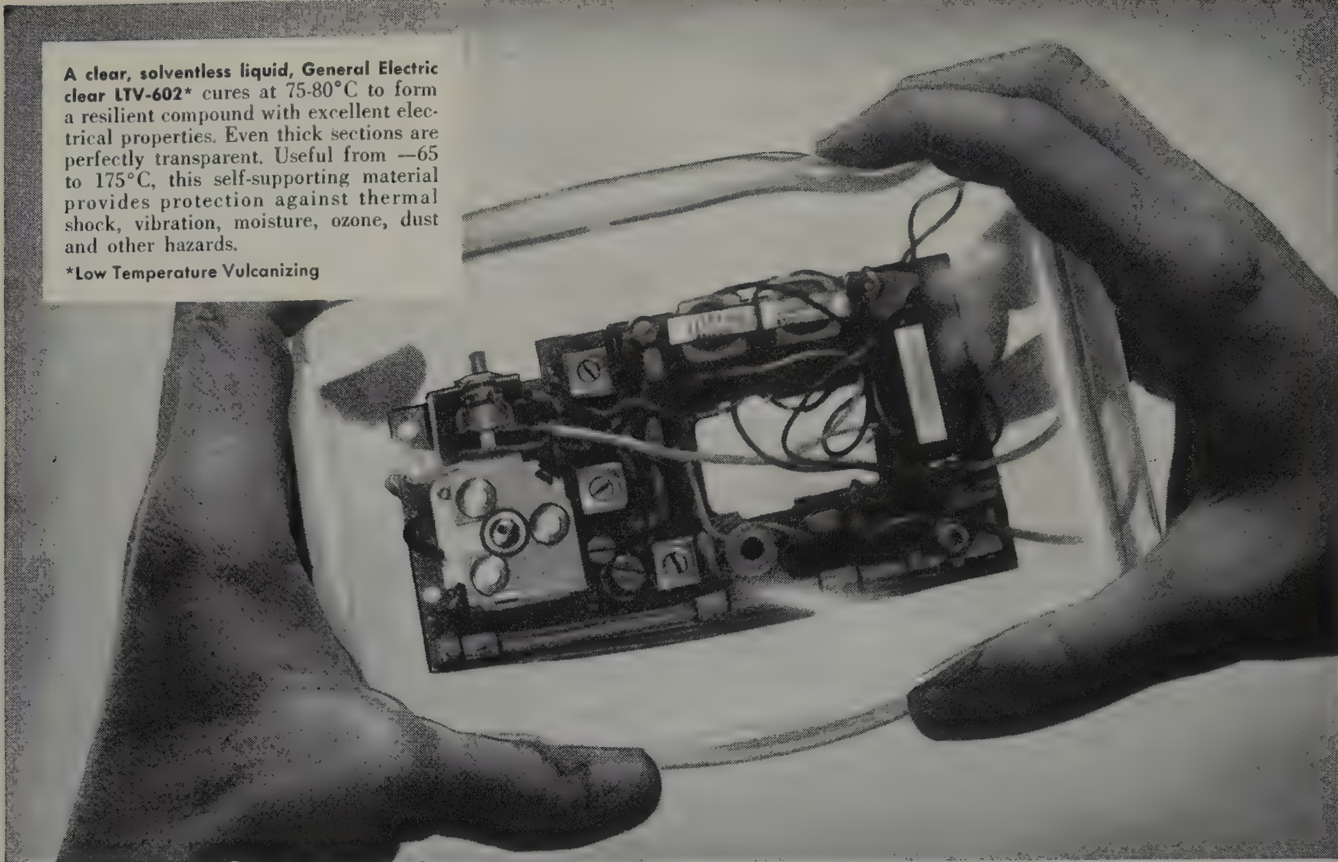
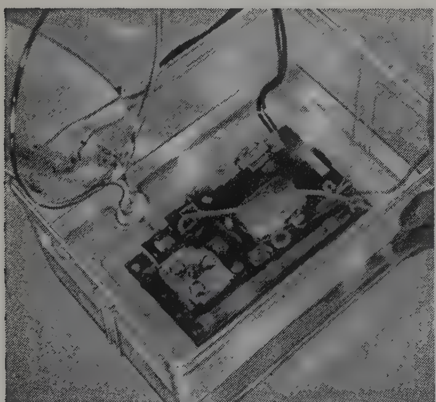


General Electric clear LTV silicone compound for potting and embedding

Transparent, resilient, self-supporting and easy to repair



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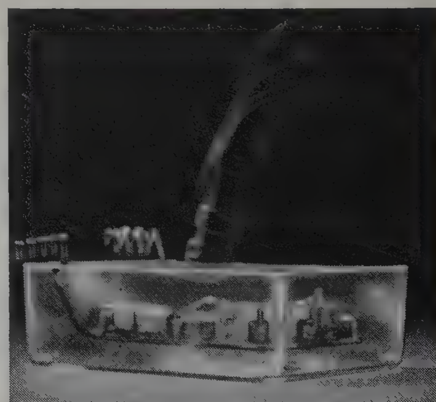
LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.



Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from —65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

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GENERAL ELECTRIC

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An Adapter to Improve Q Meter Sensitivity for Dielectric Loss Measurements of Polyethylene

By Louis A. Rosenthal, Development Scientist, Union Carbide Plastics Co., Division of Union Carbide Corp., Bound Brook, N.J., and Professor of Electrical Engineering, Rutgers University, New Brunswick, N.J.; and Thomas Hazen, Development Associate, Union Carbide Plastics Co., Bound Brook, N.J.

At the present state of the art, the dielectric properties of polyethylene low loss materials can best be measured using the benzene cell technique. Unfortunately in this measurement, the low dissipation factor taxes the resolution of the Q meter when used for these measurements. Although the G meter offers sufficient resolution, this unit is no longer available commercially. However, a device which can be adapted to a Q meter to increase its resolution by a factor of about five has been developed. In addition to being a differential voltmeter, the adapter can inject a variable conductance into the Q meter circuit. This article is divided into two parts. In the first part, the theory and design of the G adapter is presented. The second part describes certain experimental measurements that were performed using the developed instrument.

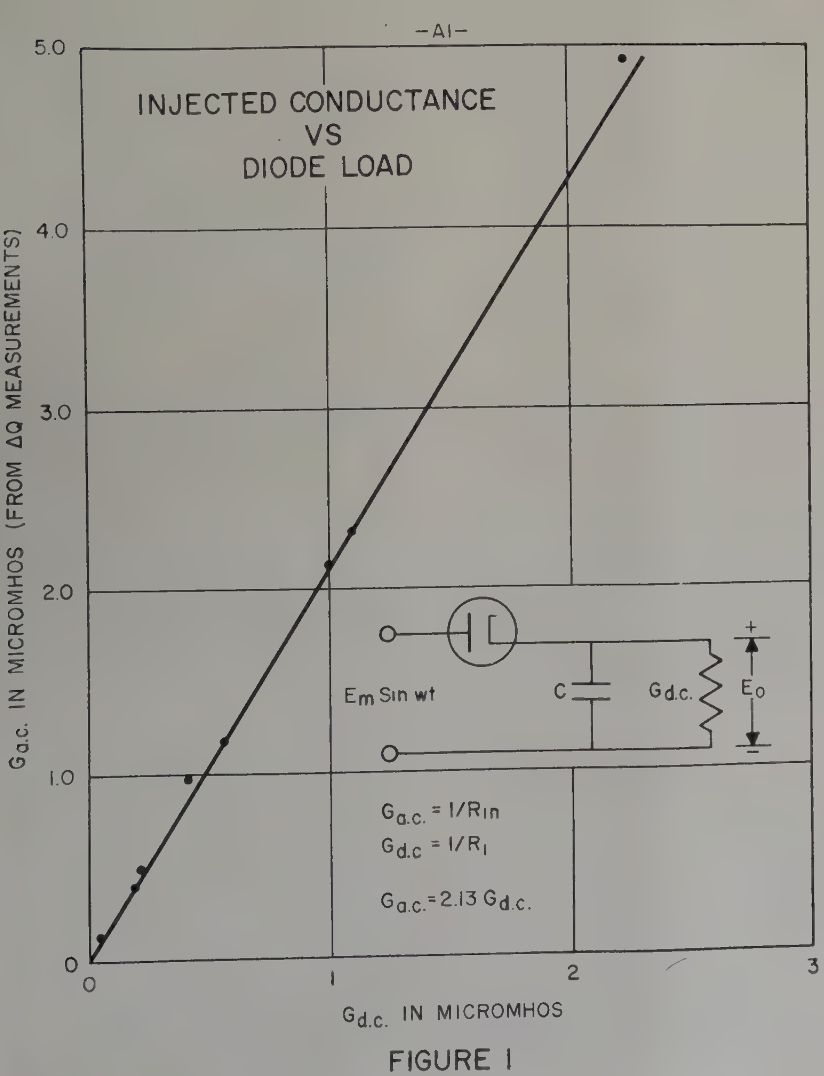


FIGURE 1

Theory and Design

The Q meter provides information in two ways. By re-resonating the main (or vernier) tuning capacity, the sample injected capacity can be resolved by a substitution technique. In addition, by reading the change in circuit Q due to the presence of the test sample, the losses of the sample, as reflected in the new circuit Q, can be determined. The reading of the Q meter proper (i.e. an a-c voltmeter nominally calibrated so that 5 volts = 250 "Q" units) provides all of the important information. The adapter is in parallel with the Q meter voltmeter, and sample, and serves two functions.

1. It is a differential voltmeter in which full scale is approximately ten (10) "Q" units.
2. It is a variable resistor which can inject a variable conductance (G) into the resonant circuit [1,2] so that "G" substitution measurements can be made.

The "G" Injection Circuit

Consider the diode peak voltmeter circuit shown as the insert of figure 1. The capacitor C is an RF by-pass which results in essentially pure d-c (E_o) across the resistor R. Although the d-c voltage approaches the maximum value of the input signal, it can never equal it and the efficiency of rectification ($E_o/E_M = \eta$) is always slightly less than 1.0. Once each positive cycle, the diode passes a pulse of current which brings up the charge of

the capacitor. The average value of the pulse current is equal to the d-c current through the resistor or

$$i_o = E_o/R_1$$

There is also a fundamental component, at signal frequency, associated with the diode current which is

$$i_\rho = E_M/R_{in}$$

Here "R_{in}" is the effective input resistance of the diode circuit. Although the shape of the current pulse is not known, we do know that it is narrow, or exists for a short part of the signal cycle. From Fourier series analysis of pulse wave shapes, it is known that

$$i_\rho = \frac{1}{\Pi} \int_o^{2\Pi} i\ (\theta)\ \mathrm{Cos}\,\theta\ d\,\theta$$

and

$$i_o = \frac{1}{2\Pi} \int_o^{2\Pi} i\ (\theta)\ d\,\theta$$

If the current function $i(\theta)$ exists for only a short time during which $\mathrm{Cos}\ \theta \approx 1$, the simple relation

$$i_\rho \approx 2i_o$$

results. It is true that a narrow pulse has a fundamental component which is *twice* the d-c value. Using this relationship with the previously derived equations

$$R_{in} = R_1/2\ \ (E_o/E_M) = R_1/2\eta$$

Since η approaches 1.0, then $R_{in} \approx R_1/2$, or the injected a-c resistance is ½ the d-c resistance. Similarly, the injected conductance G is

$$G = 2/R_1$$

All of the relationships indicated are approximately true for the assumptions made. The experimental curve of figure 1 shows the injected conductance to be $2.13/R_1$ with good linearity, as determined by Q meter measurements. This is a good check, since 10% resistors were used as the diode load (R_1). If the load is made up of a fixed 5 megohm and a variable 5 megohm resistor, then it is possible to inject a variable component of conductance which varies from 0.2 to 0.4 micromhos. Thus, a substitution procedure can be applied wherein the injected conductance is decreased to compensate for the sample conductance. It should be noted that the injected resistance has a small voltage coefficient or is slightly dependent on the diode voltage level. This is a result of the diode nonlinearities.

The Differential Voltmeter

To utilize the variable "G" feature, it is desirable to increase the resolution of the Q meter. This can be accomplished by using a differential voltmeter across the "Q" meter voltmeter. The circuit diagram of the differential voltmeter is shown in figure 2. Two diodes (6AL5) are placed across the resonating capacitor terminals of the "Q" meter. One diode supplies the variable "G" or conductance and has a load which can be varied from 5 to 10 megohms. A second diode, operating as a peak rectifier, provides a d-c signal (E_o) which is passed on to a difference amplifier. The two sections of the twin triode (12AU7) operate as a bridge voltmeter. One grid has a signal corresponding to the peak R F voltage of the Q meter (E_o) and the other grid has a reference or comparison voltage (E_r). A meter (M) senses the difference between these two voltages between the cathodes of the corresponding tubes. It is possible to adjust the reference voltage so that no current flows through the meter. Now for a change in measured voltage (ΔE_o), the meter current is closely

$$i_m = \frac{\Delta E_o}{\frac{2}{g_m} + R_M}$$

In this equation R_M is the meter resistance and g_m is the tube transconductance. Since the g_m is a function of the quiescent tube current, the sensitivity of this differential detector is partly determined by the initial value of the voltage being measured.

A diode (1N93) is placed in series with the meter to prevent overloading the meter if signal is lost at the Q meter probe. This feature is considered necessary since the probe is expected to experience a wide range of voltages. The meter employed is a 250 microampere meter with 60% of the current range suppressed. A suppressed zero obscures all of the protective diode's nonlinearities. The meter will read when the rectified voltage E_o exceeds the reference voltage E_r by about 250 millivolts and full scale deflection will correspond to an additional voltage difference of about 250 millivolts. As previously indicated, the Q meter signal available is 0-5 volts (a-c) for 250 indicated Q units. This would result in a voltage E_o of 0-7 (peak rectified) or the 250 millivolts differential full scale sensitivity corresponds to about 9 Q units.

The differential sensitivity depends on the initial level as shown in figure 3. This is a result of the tube's "g_m" being dependent on the initial current. The curves were obtained by putting a d-c signal (E_o) into the differential voltmeter. For all cases, the input signal corresponds to full scale meter deflection; and as it is decreased, the deflection decreases. In effect, this differential voltmeter expands the region of resonance so that the peak, and 10 "Q" units drop on each side, are observed.

There are essentially two ways to use the meter. It can be used to measure ΔQ with high accuracy and resolution with the injected conductance of the G injection circuit a minimum. Another technique will use the meter only as a peak indicator, and the injected conductance will be varied to keep the total circuit conductance a constant. The former case requires an accurate calibration of ΔQ vs meter reading; while the latter case requires a calibration of injected conductance vs diode resistance (or R_1 scale reading). The latter or substitution procedure avoids any errors due to nonlinear loading of the Q meter voltmeter on the resonant circuit. It has been observed that this type of nonlinear loading can introduce serious errors in low loss determinations. Both techniques will be described, together with certain experimental measurements made with this adapter.

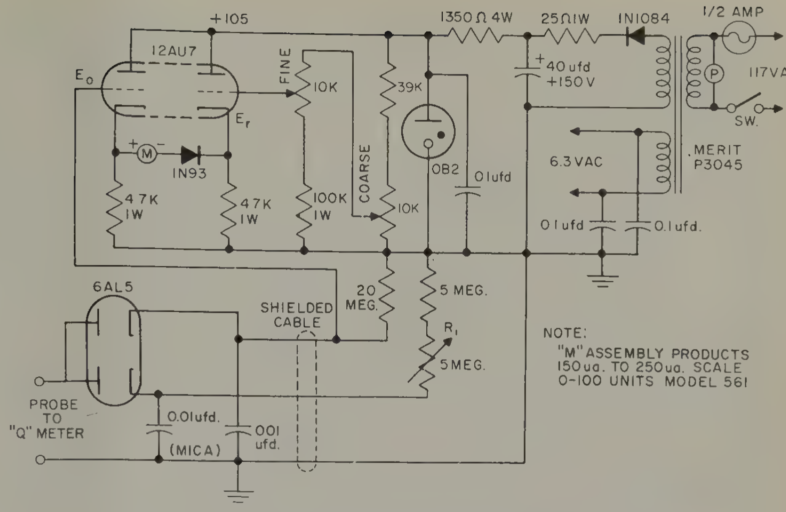
Application of the G Adapter

While the application of the G adapter described in this article is not restricted to the measurement of dissipation factors of very low-loss polyethylenes at 1 mc by the benzene-displacement ("benzene cell") technique, this is the specific use of principal interest. Experimental tests of the equipment, therefore, have so far been confined to this type of measure-

ment, using the test cell (which was originally designed by Bell Telephone Laboratories) and measurement technique outlined in ASTM Method D1531-59T[3]. Measurements have also been at 100 kc with similar convenience and accuracy. The only change required was the increase of the diode resistance by a factor of 10.

Although originally developed to obtain maximum accuracy and precision (reproducibility) of dielectric constant values for polyethylene compounds intended for primary insulation of submarine telephone cables, the "benzene cell" method has also provided enormously improved certainty for determination of the dielectric loss at low levels. This has come about because of the relatively large area of specimen material that is subjected to test. With this high precision in dielectric constant measurements, the next logical step for specification and control test purposes was to take advantage of the inherent possibilities of the method as a means of improving the reliability of dielectric loss determinations. This eventually resulted in the appearance of dissipation factor specifications which require measurements of dissipation factors of the order of 0.00010 with reproducibility of ±0.00001. Such requirements have taxed the sensitivity of existing test apparatus, such as the Q meter, which is perhaps the most widely employed commercially available equipment for dielectric measurements at radio frequencies, i.e. in the frequency range between about 100 kc and 50 mc.

Even with the employment of an inductor or coil of the highest practically attainable Q, viz., about 500 to 600, the type 260-A Q meter (manufactured by Boonton Radio Corp.) will just barely provide adequate sensitivity, when the so-called "ΔQ feature" of this instrument is taken advantage of, to meet the new precision requirements for dissipation factor. The *G Adapter* described in this paper has therefore been conceived as a means of further enhancing the performance of the Q meter for dielectric loss measurements on electrical grades of polyethylene, and at the same time providing a simplification of the procedures for both the instrumental measurement and calculation of dissipation factors. The principle of the adapter is based on the original work described by E. O. Weaver and W. A. McCool[1], and later employed by Boonton Radio Corp. in the type 192-A conductance meter ("G Meter"), which is no longer in production. The slight modification of the original Weaver-McCool and Boonton "G Meter" equipments that is used in the *G Adapter* described in this paper—a modification pertaining to the source of the reference voltage for the differential voltmeter detector system—results in performance characteristics that fall somewhat short of those of the type 192-A "G Meter." This deficiency, however, is offset to a considerable degree by the relative simplicity and low cost of the *G Adapter* for the Q meter. The *G Adapter* described, in short, converts the standard Q meter to a G Meter for operation at 1 mc for the measurement of dissipation factors in the range 0-0.00025, approximately, by the technique and test cell of ASTM Method D1531-59T.



G ADAPTER CIRCUIT DIAGRAM

FIGURE 2

The Benzene Cell Technique

In brief outline, the benzene-displacement method for the determination of dielectric constant and dissipation factor of polyethylene consists of measuring the small change of capacitance, ΔC, of a two-terminal, parallel-plate, shielded test cell containing benzene when sheet specimens of polyethylene are introduced between the plates, displacing some of the benzene, and of determining the difference between the dissipation factor of the cell with benzene alone and with the polyethylene immersed in it. The dielectric constant of the test specimens is calculated from the small capacitance difference, ΔC, the specimen thickness, the cell dimensions, and the precisely known dielectric constant of the benzene, which, incidentally, is chosen as the "standard" liquid because its dielectric constant is very nearly the same as that of polyethylene. Since at radio frequencies the dissipation factor of reagent grade benzene is found to be essentially zero, it can be neglected, so that the dissipation factor of the polyethylene test specimens is calculated by multiplying the difference between the dissipation factor of the cell with benzene only and with the combination of benzene and polyethylene by the ratio of the cell plate spacing to the average specimen thickness. The dissipation factor, D_c, of the combination of test specimen and benzene is given by

$$D_c = \frac{\Delta G}{\omega\,[C + \Delta C]},$$

where C is the effective capacitance of the cell containing benzene alone and is conventionally arrived at by multiplying the geometric air capacitance of the cell electrode system by the dielectric constant of benzene. In the standard cell of ASTM Method

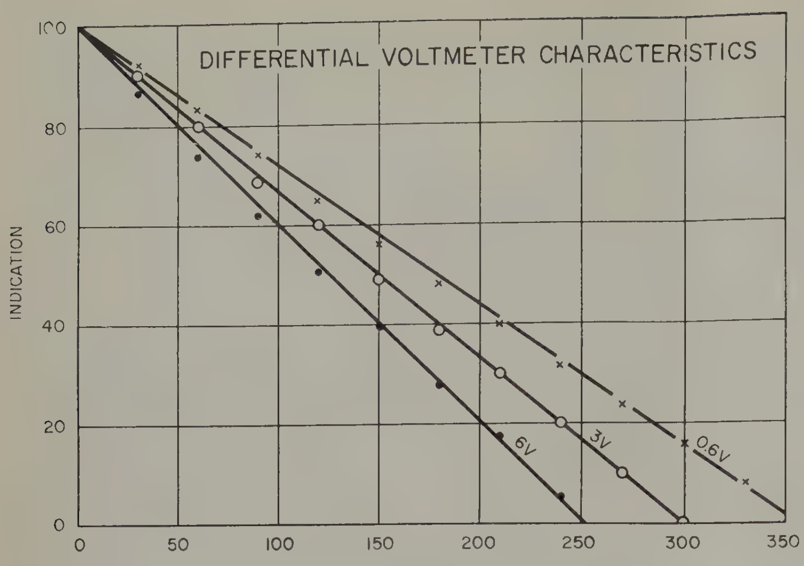


FIGURE 3

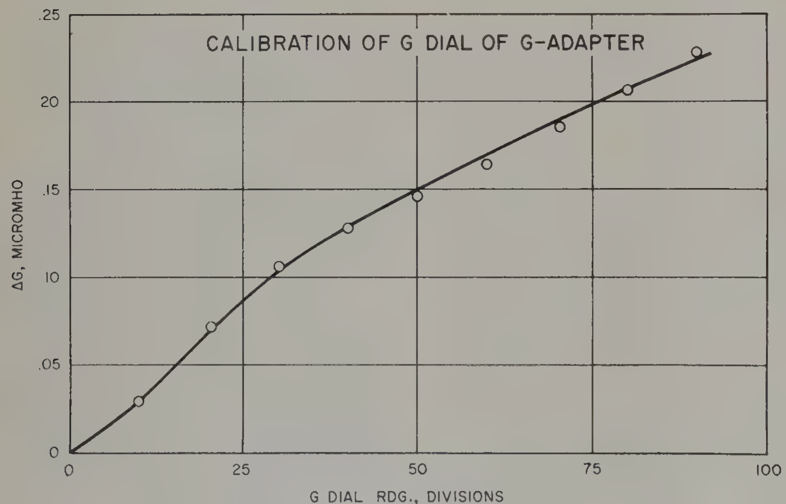


FIGURE 4

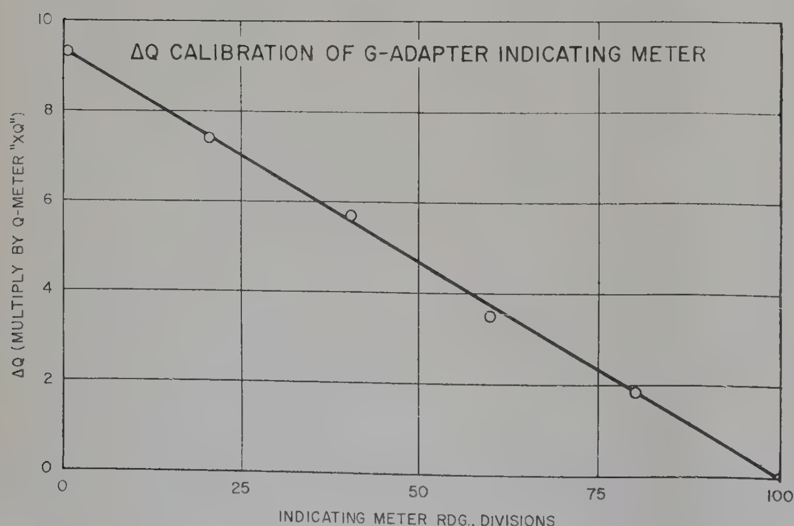


FIGURE 5

D1531-59T, the value of C is about 150 pf. In general, ΔC is very small, so that the term $(C + \Delta C)$ normally may be used as 150 pf, approximately, depending upon the exact dimensions of the particular cell that is used. The ΔC term should not be neglected in measurements on high density polyethylenes, which have dielectric constants that are substantially higher than that of benzene. The dissipation factor, D_X, of the polyethylene is then simply determined from

$$D_X = D_c\ (t_a/t_s),$$

where t_a and t_s are the plate spacing of the cell and specimen thickness, respectively.

The dielectric constant, K_X, of the polyethylene is calculated from the following:

$$K_X = K_B + \frac{\Delta C}{C\alpha}(t_a/t_s),$$

where K_B is the dielectric constant of benzene at the exact temperature of the test, $C\alpha$ is the geometric air capacitance of the cell electrode system, and ΔC is the experimentally determined capacitance change described previously. This equation is an approximte form of an exact relationship given in ASTM D1531-59T, but it is adequate for all cases where K_X does not differ from K_B by more than about ± 0.1.

Calibration of the G Adapter

Before the *G Adapter* can be used, it is necessary that a calibration of the dial of the variable portion of the diode loading resistor R_1 be made in terms of ΔG. The preferred, or recommended, operational procedure in a measurement consists of first tuning the Q meter circuit (with *G Adapter* in place and cell containing benzene alone connected) to exact resonance and adjusting the indicating meter of the *G Adapter* to full scale (100). Then, upon introduction of the polyethylene specimens, the circuit is retuned by the Q meter vernier capacitor and the indicating meter reading is returned to full scale (100) by rotation of the G dial (variable R_1) to decrease the circuit conductance by an amount exactly equal to the conductance that was added by insertion of the specimen. This requires that the total diode load resistance be mini-

mum (G maximum) for the initial condition before specimens are inserted, since by increasing R_1 by the proper amount after insertion of specimens, the circuit conductance is decreased to cancel the conductance added by the specimens in benzene. The diode load resistance is therefore 5 megohms when the G dial reads zero, and is increased toward the full 10 megohms as the dial reading is increased. The total conductance change possible with the circuit of figure 2, as the G dial is rotated from 0 to full scale (about 100) represents a decrease of approximately 0.2 micromho. This is the difference between the diode circuit conductance (0.4 micromho) when the diode load resistance is 5 megohms and the diode circuit conductance (0.2 micromho) when the diode load resistance is increased to the full 10 megohms. With the 150 pf capacitance of the cell containing benzene and polyethylene in series, this conductance range corresponds to a specimen dissipation factor range of 0 to about 0.00025 for 50-mil sheets in a cell with standard 60-mil plate spacing.

The calibration of the G dial is derived from changes in circuit Q, read from the Q meter "ΔQ" scale, as the G dial is moved step-wise to different positions spanning the whole range of rotation, starting with the dial at full scale (R_1 all in). The curve of figure 4 is typical. This calibration was checked directly against the Boonton type 192-A conductance meter ("G Meter") at 1 mc with very close agreement. The calibration against the "ΔQ" readings of the type 260-A Q meter were made using a high-Q coil.[4] This inductor had a Q of about 600 at 1 mc, and resonated at this frequency with a total circuit capacitance of approximately 215 pf. It is also satisfactory to use d-c calibration of the diode load to determine the injected conductance.

Table 1—Dissipation Factor and Dielectric Constant at 1 MC, 24°C, of Representative Polyethylenes by Three Different Methods

Sample	(1) Q Meter + G Adapter D	(1) Q Meter + G Adapter K	(2) Q Meter Alone D	(2) Q Meter Alone K	(3) G Meter, 192-A D	(3) G Meter, 192-A K
A	.000108	2.2751	.000107	2.2767	.000106	2.2747
B	.000038	2.3542	.000031	2.3546	.000041	2.3530
C	.000034	2.3038	.000025	2.3041	.000034	2.3029
D	.000041	2.2980	.000040	2.2989	.000042	2.2974
E	.000118	2.2832	.000124	2.2834	.000123	2.2823
F	.000246	2.2866	.000254	2.2872	.000261	2.2863
G	.000140	2.2744	.000143	2.2744	.000143	2.2734

Table 2—Dissipation Factor and Dielectric Constant of Polyethylene Specimens by Use of Q Meter G Adapter: Alternative Procedures

Sample	(3) G Adapter Indicating Meter for △ Q: Q Meter Principle (Total ΔQ Range, About 9 x 2) D	K	(4) G Adapter G Dial Used with Q Meter "ΔQ" Indicator for Conductance Balance D	K
A	.000118	2.2751	.000116	Identical with values in column (3)** of this table.
B	.000039	2.3542	.000035	
C	.000029	2.3038	.000030	
D	.000046	2.2980	.000044	
E	.000123	2.2832	.000122	
F	---------*	2.2866	.000266	
G	.000151	2.2744	.000148	

**Out of range; ΔQ greater than 9.3 x 2 (meter reading below 0 of scale).*
***These are identical because based on same ΔC readings in each case; they also agree exactly with K values in column (1) of table 1 for the same reason.*

Experimental Observations

The real test of the performance is best demonstrated by actual measurements on typical polyethylene specimens. A set of seven different specimens was chosen to represent dissipation factor levels covering the useful range of the present *G Adapter* apparatus. Measurements of dissipation factor at 1 mc were then made by three different methods, as follows:

1. With the type 260-A Q meter, using the *G Adapter* to determine the specimen conductance;
2. With the type 260-A Q meter, without the *G Adapter*, using a high-Q (600 approximately) inductor and the "ΔQ" feature;
3. With the Boonton Radio type 192-A conductance meter ("G Meter").

The following tabulation (table 1) of the results of the three sets of measurements on the seven specimens of polyethylene shows that the agreement among the three measurement methods was remarkably good. All measurements were made by the benzene-displacement technique. Use of the *G Adapter* results in a considerable simplification in dissipation factor computations as compared with the regular Q meter method, as has been indicated.

The *G Adapter* described in this article is not limited to the direct measurement of conductance, although this is the preferred technique. The instrument can also be used as a differential voltmeter for measurement of ΔQ by use of a predetermination of the ΔQ vs indicating meter reading. Theoretically, a calibration of the instrument meter indications, with the G dial set at full scale (minimum conductance), gives a linear variation with circuit ΔQ and an amplification of the Q meter ΔQ scale by a factor of about five. Actual performance is somewhat less, apparently due to slight variability of the oscillator signal fed to the Q circuit. A determination of circuit ΔQ vs *G Adapter* readings with the same high-Q coil that was employed in the tests described earlier gave a linear calibration and a total ΔQ of 9.3 x 2, corresponding to full scale of the *G Adapter* indicating meter. The factor

of two is due to the Q multiplier setting. The plot of this calibration is shown in figure 5. Measurements of ΔQ obtained by this calibration were made from observations taken simultaneously with the data used to obtain the dissipation factors reported in column (1) of table 1. The results of dissipation factors for the seven polyethylene specimens, A through G, are given in table 2.

A still further application of the *G Adapter* was used simultaneously with the measurements described in the preceding paragraph. This consisted of using the G dial of the adapter but employed the ΔQ red scale of the 260-A Q meter as the indicating detector of restoration of circuit conductance to its original value before specimens were inserted. Thus the differential voltmeter was not used. Dissipation factors for the seven polyethylene specimens were computed from the readings of the G dial (and its calibration). These are also reported in table 2.

Thus, it is seen that the G Adapter has been used by three methods of operation, and that quite satisfactory agreement among the results of dissipation factor measurements was obtained.

Conclusions

The use of the G Adapter has provided greater resolution with no loss in accuracy in these measurements. It conveniently provides a direct evaluation of the sample conductance, thus simplifying the dissipation factor computation. In principle, there is no restriction in frequency. This simple device has enhanced the use of the Q meter in low loss dielectric measurements.

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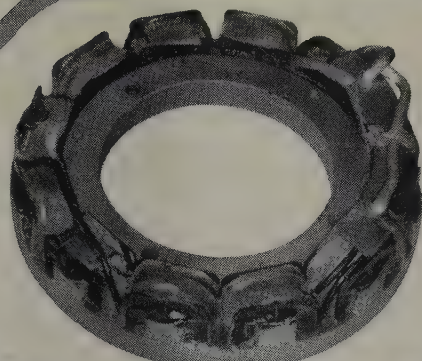

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Thin Dielectric Films, Epoxies Covered at Electrochemical Society Meeting

At last month's 119th meeting of The Electrochemical Society in Indianapolis, the Electric Insulation Division presented a total of some 20 papers dealing with thin dielectric films and epoxy resins. An excellent array of papers and high interest in the subject matter resulted in temporary overcrowding with standing room only for early sessions—this situation has prevailed for the last few years and testifies to the growing awareness of the importance of insulation on both engineering and scientific levels and to the quality of the Electric Insulation Division programs.

At the Electric Insulation Division business meeting, Thomas Callinan, Research Center, International Business Machines Corp., Yorktown Heights, N.Y., was elected chairman; Charles C. Houtz, Member of the Technical Staff, Bell Telephone Laboratories, Murray Hill, N.J., was elected vice chairman; and Barlane R. Eichbaum, manager, Molecular Electronics Department, Aeronutronic Division, Ford Motor Co., Newport Beach, Cal., was elected secretary-treasurer. New members of the executive committee are Hans Thurnauer, Head, Inorganic Section, Minnesota Mining and Manufacturing Co., and A. Sharbaugh, Research Laboratory, General Electric Co., Schenectady, N.Y.

Preliminary plans for the 1962 spring meeting in Los Angeles were outlined—symposia will probably be scheduled on the electrical properties of ceramics and/or the electrical properties of papers. The possibility of an insulation session at the 1961 fall meeting was also discussed.

There follows brief news reports on several of the papers.

Electrical Properties of Evaporated Aluminum Oxide Films

By E. M. DaSilva and P. White, International Business Machines Corp.

This report described the preparation and characteristics of aluminum oxide capacitors made up of thin films of aluminum oxide deposited between aluminum electrodes by evaporation techniques. The metal electrodes were prepared by high vacuum evaporation of aluminum source in an oxygen atmosphere. The values of the dielectric constant and the dissipation factor of these films were measured and compared with the electrical properties of aluminum oxide films formed by anodization.

The values of dielectric constant and dissipation factor were measured immediately after preparation in vacuum and after exposure to air. The large percentage change in dielectric constant on exposure to air seems to be about the same for each sample within experimental error. There appears to be little relation between the changes in dielectric constant and the changes in dissipation factor. The dielectric constant changes only slightly on being stored in vacuum, remains constant on admission of nitrogen to the sample, but increases considerably on subsequent exposure to air or oxygen. The values of dissipation factor on the other hand initially decrease on being stored in vacuum, remain constant on admission of nitrogen, and then increase by a very large factor on admission of oxygen. The final values of dissipation factor were approximately the same as in the case when nitrogen was not admitted to the bell jar prior to admission of oxygen.

The insulating film formed by evaporation of aluminum in oxygen has a dielectric constant of about 6 and is obviously different from an anodized layer of aluminum which has been reported to have a dielectric constant of about 10. On exposure to one atmosphere of oxygen or air, however, the dielectric constant rises to a value of about 11 and remains fairly constant. The dielectric constant, the temperature variation of the dielectric constant, and the dissipation factor for this material are about the same as that of anodized layers of bulk alumina and it seems probable that this film is similar to the bulk oxide.

A condition now exists in which the initial insulating film formed by evaporation in an oxygen atmosphere is converted by exposure to one atmosphere of oxygen to an insulating film having physical properties similar to those of the bulk oxide Al_2O_3. We can infer, therefore, that the initial insulating film is a highly oxidized aluminum film with insufficient oxygen to form Al_2O_3 but which will react with excess oxygen to form a stable oxide similar to Al_2O_3. Both dielectric constant and dissipation factor of the suboxide are lower than the corresponding values of Al_2O_3.

In conclusion, on exposure to air both dielectric constant and dissipation factor increase to the values similar to those previously observed for anodized films on bulk aluminum. The results can be understood if the initial insulating film is a suboxide similar to the postulated AlO which is normally unstable at room temperature in air or oxygen, decomposing to Al_2O_3.

A Flame Resistant Resin from Bisphenol A

By R. A. Cass and E. T. Reaville, Monsanto Chemical Co.

From bisphenol A comes the remarkable polycarbonate resins which are self-extinguishing. It is probable that the reason for the polycarbonate's stability is because of the bisphenol structure which is a large portion of the molecule. The amine cured epoxy resin from epichlorohydrin and bisphenol A has a remarkable resistance

to boiling caustic (10% NaOH). This resistance has previously been attributed to the presence of ether groups in the resin network. However, an ethylene oxide bisphenol A unsaturated polyester cured with styrene and containing both ether and ester groups is as resistant to boiling caustic as the amine cured bisphenol A epoxy resin. When an unsaturated polyester is prepared from hydrogenated bisphenol A and maleic anhydride and cured with styrene, a new polyester results which is as resistant to hydrolysis as the amine cured bisphenol A epoxy resin and the polyester from ethylene oxide, bisphenol A and maleic anhydride. It has been reasoned that the resistance of the amine cured bisphenol A, epichlorohydrin epoxy resins was due to the absence of hydrolyzable ester groups. However, since polyesters prepared from hydrogenated bisphenol A and from bisphenol A are as resistant to boiling caustic as the amine cured bisphenol A epoxy resin, it is evident that this remarkable property may well be the result of the bisphenol structure in these three resins.

This paper reported some of the properties of resins prepared from tetrachlorobisphenol A cured with methyl nadic anhydride (MNA), a mixture of maleic anhydride (MA) and pyromellitic dianhydride (PMDA) and a mixture of pyromellitic dianhydride and phthalic anhydride (PA). It reported in greater detail on the properties of the resin cured with phthalic anhydride and compared these properties to those of the diglycidyl ether of bisphenol A (DGE BPA) cured with phthalic anhydride and chlorendic anhydride (CA).

Conclusions reached were that the diglycidyl ether of tetrachlorobisphenol A hardened with phthalic anhydride has the following properties: (1) It is flame resistant—self extinguishing. (2) It has good pot life which can be readily controlled. (3) Maximum properties can be attained with a relatively short cure cycle. (4) Although "DMP 30" at higher levels does reduce both flexural strength and HDT, in the range 0.1 to 1.0% the properties of the cured resin are not too sensitive to cure cycle and catalyst level. (5) Optimum properties occur at the ratio of 1.0 mole of phthalic anhydride per epoxide equivalent weight. A resin with a flexural strength in excess of 25,000 lb./in.^{2} and a HDT above 160°C can be prepared using properly selected conditions. (6) The resin has excellent high temperature stability in contrast to its amine cured counterpart. (7) The chemical resistance of both the clear and the laminated resin are as good as, or better than, the resin prepared with BPA DGE and phthalic anhydride or BPA DGE and chlorendic anhydride. (8) Electrical properties are comparable with phthalic anhydride cured BPA DGE. (9) Laminates can be prepared by B-staging.

Thus, a new resin raw material is now available from which epoxy resins can be made offering some very special advantages.

Silicone Epoxy Resins in High Temperature Structural Laminates

By John R. Bond and Sam A. Brady, Dow Corning Corp.

The introduction of silicone reactive intermediate resins offered an opportunity to combine the good features of epoxy and silicone resins to form one with (a) high physical strength, (b) stability at elevated temperatures and (c) the unusual electrical properties of silicones. The data presented was based on a preliminary investigation of the properties of silicone-epoxy resins for use as laminating resins.

The resins made for the study of this system are copolymers. The silicones used were reactive, unbodied, intermediate resins containing hydroxyl (silanol) groups attached to silicon as the reactive site. The epoxy resins used were of three types: 1) The epichlorohydrin-bisphenol A condensation products. 2) Shell Epon 1031, a tetrafunctional epoxy recommended for high temperature applications. 3) A Dow epoxy novolac, X-2638.3.

As a preliminary study, a series of copolymers were made from Dow Corning Z-6018, a monophenyl reactive silicone resin, and Shell Epon 1001. Resins containing 25, 50, and 75% silicone were evaluated as laminating resins using 6 phr metaphenylene diamine as catalyst. The 25% silicone resin copolymer gave the best physical properties, having higher initial strength and better retention of strength on heat aging. The electrical properties of all the silicone-modified resins were about the same. There was an improvement over the epoxy resin in arc resistance and dissipation factor.

Since only a small portion of epoxy groups is destroyed in making these resins, the silicone-epoxies may be cured by the same mechanism as epoxy resins. The next step in this project was to decide on a curing agent for screening all of the resins. Laminates were made with the 25% silicone resin copolymer and various curing agents. After 200 hours at 500°F flexural strength tests indicated that there were three anhydrides and one amine curing agent that showed promise. It was decided to use methyl nadic anhydride because: 1) It gives laminates as good as, if not better than, the other three curing agents. 2) It is easy to work with, thus reducing the chance of error.

Recommended catalyst concentration of 85% catalyst/epoxy mole ratio seems to be best when using MNA as a curing agent, demonstrating that silicone-epoxy resins cure by the same mechanism as epoxy resins.

Using 25% silicone resin copolymers as optimum, two new epoxy resins were investigated—Epon 1031 by Shell Chemical Company and X-2638.3, an epoxy novolac resin made by The Dow Chemical Co., modified with Z-6018.

Results show that silicone epoxy combinations of the more highly functional epoxy resins give considerably better flexural strengths at 500°F, but lower strengths at room temperature.

Previously the ratio of 25% silicone and 75% epoxy resin had been established as the optimum concentration for a monophenyl silicone intermediate. This silicone intermediate is a hard brittle resin having little strength in laminates. For this reason the intermediate stage of a silicone laminating resin was combined with

some of the heat stable epoxies. At high silicone content the physical strength of the resin is a little higher than that of pure silicone. However, the silicone epoxy cures more easily and gives somewhat better physical properties. At low silicone content the silicone epoxy laminates have higher flexural strength than either epoxy or silicone. This is reflected especially at 10-25% silicone.

To see what difference the type of silicone could make at low silicone content, a series of resins was made in which the amount of substitution on silicone was varied. It appears to make little difference what silicone is used since the strengths are all approximately the same. This is probably due to the fact that all of the silicones had approximately the same hydroxyl content, therefore giving nearly the same degree of crosslinking with the epoxy resin. Also, because of the relatively low concentration of the silicone the properties of the silicone-epoxy resin would be essentially those of the epoxy resin.

Besides physical properties, electrical properties of these resins were also checked. It was thought that the electrical properties might be a compromise between both resins. However, at 25% silicone no matter what silicone was used, the dielectric constant increased with increased temperature. This increase in the constant was greater than the increase observed using 100% epoxy resin. But at 75% silicone the dielectric constant did not change through 250°C, which is comparable to the behavior of laminates made with 100% silicone. One explanation for the behavior of the constant at 25% silicone could be a lack of thorough cure. The dissipation factor shows the same behavior.

Wet and dry volume and surface resistivity values were obtained from all of the laminates tested. The values, including the straight epoxies, were: dry, 10^{13}-10^{16} ohm; wet, 10^{11}-10^{12} ohm. These values are comparable to the properties of other good electrical resins.

To summarize, the properties of silicone-epoxy resins tested in laminates indicate certain advantages. At low silicone concentration, 10-25%, the resins have as good as or better physical properties than 100% epoxy resins. The silicone-epoxy resins also have improved heat stability over straight epoxy resins. At high silicone content, the laminates have a little higher strength and retain the excellent electrical properties of silicones.

Cured Epoxy Systems in Dilute Mineral Acids

By John Delmonte, President, Furane Plastics Inc.

Among the many variables influencing the performance of epoxy resin systems in mineral acid solutions are the following: 1) Nature of Curing Agent; 2) Stoichiometric Ratio (In general, an excess of curing agent is more detrimental to chemical resistance than less); 3) Long Time Exposure; 4) Effect of Stress (It has been demonstrated that epoxy resin systems exposed to chemicals while under physical stress will fail more rapidly than when exposed under strain-free conditions); 5) Temperature (In principle, the higher the solution temperature, the poorer will be the performance of the plastic); 6) Fillers (Formulated epoxy resins which offer superior performance to base resins were described in this paper); 7) Cure (Pronounced undercure and prolonged over-cure will adversely affect physical retentivity in chemical solutions. In general, it is recognized that heat cured epoxy systems are superior to room temperature cured epoxy systems in chemical resistance.)

Utilizing test methods involving weight changes in distilled water and in 5% sulfuric acid at 150°F, numerous epoxy resin systems and their modifiers were examined. Low viscosity epoxy resins have been proposed as additives to the more viscous diglycidyl ethers of bisphenol A to assist wetting and laminating. Data showed that some additions appear more promising as additions to epoxy resin systems than others where resistance to dilute mineral acids is indicated.

Test data on a few of the better known mono-epoxides used as reactive diluents for epoxy resin systems were summarized. Of the three materials reported, it is clear that styrene oxide modifications have a slight edge when the materials are exposed to dilute mineral acids at 150°F.

The chemical resistance of the epoxy resin system is influenced to a great degree by the nature of the curing agent and its concentration. Whereas optimum stoichiometric ratio appears to favor the optimum water resistance, less than the optimum ratio appears favorable to better acid resistance.

The changes in weight of a number of resilient epoxy systems were reported. Tensile strength and elongation data were included to illustrate how the chemical resistance in water and 5% sulfuric acid is degraded at greater flexibilities. Long time exposures on polyamide epoxy coatings indicate better gloss retention over the amine cured epoxies.

The modulus of elasticity and short time creep under stress indicate the onset of chemical attack. Commercial concentrated nitric acid (62%), commercial concentrated HCl (37%), and 30% sulfuric acid were the media into which were placed test specimens of a system selected because previous literature had indicated the superiority of such a system to chemicals. The attack of nitric acid was obvious. Good performance in the HCl and H_2SO_4 is indicated.

Properties of Paper Based and Glass Based Copper Clad Epoxy Laminates

By Herbert R. Levine, Laminated Products Department, General Electric Co.

High flexural and tensile strengths, very low moisture absorption, good dimensional stability, superior resistance to aging, good machinability, excellent bond to copper circuit foil—these are the mechanical properties which characterize copper-clad epoxy laminates used for printed circuit applications. To these mechanical properties is added an array of electrical properties which are retained to a high degree even after exposure to moisture. These include low dissipation factor at low and high frequencies, high dielectric strength, remarkable insulation resistance, and low dielectric constant. In addition, epoxy

laminates possess a high degree of resistance to the chemical action of the fluxes, solvents, etchants, plating solutions, and molten solders used in the fabrication of printed circuits.

There are two broad classes of copper-clad epoxy laminates: those based on paper and those based on glass fabric.

The choice of resins, curing agents and additives used in the manufacture of copper-clad epoxy-glass laminates is dictated in approximately equal parts by the nature of the application and by the manufacturing process. Shelf life of the pre-preg is important to the laminator, and is a limiting factor in the choice of any particular system of resin, curing agent, catalyst, and additive. The bulk of these laminates is made by the dry lay-up method. The resin content, the degree of solvent retention and the degree of polymerization of the pre-preg all have profound effects on the properties of the subsequent laminate. Pressing pressure, temperature, rate of temperature rise, and time are additional variables which the laminator controls to determine the properties of the laminate. The same base material and the same epoxy resin can be combined by the laminator to produce markedly different laminates, as functions of the variables just detailed above.

With notable exceptions, the epoxy resins currently used are reaction products of bisphenol A and epichlorohydrin or their derivatives. The epoxide equivalent weight of these resins ranges from 140 to 550 grams. The catalysts, or more properly the co-reactants, employed include Lewis acids, such as the monoethylamine complex of boron trifluoride, primary, secondary and tertiary amines, dicyandiamide, a considerable variety of acid anhydrides, and a number of others utilized for the specialized properties they donate to a particular system.

Additives are incorporated in resin formulations either to impart special properties to the product or for purposes of economy. Epoxy-glass laminates are not inexpensive; the glass fabric used is costly and, of the popular themosetting resins used in laminates, only the silicones exceed the epoxies in price.

A real savings in weight can be realized from epoxy-glass laminates' flexural strengths which range from 60,000 psi upward, with tensile and impact strengths to match. However, where the applications permit, inert extenders can be used to reduce resin content. These include triphenyl phosphite, a variety of phosphates, antimony oxide, and diatomaceous earths, to name a few.

To improve flexibility, internal plasticizers are used to a limited extent. In general, these materials are reactive and frequently combine with the epoxide oxygen to provide relatively long, usually aliphatic linkages which afford some degree of freedom of molecular rotation without excessive loss of mechanical or electrical properties. Chlorinated additives, usually reactive, are occasionally incorporated in resin formulations to render self-extinguishing the normally slow-burning but flammable epoxy laminates.

Worthy of special mention are the epoxy-paper laminates, which of the laminates, are probably the largest single user of epoxy resins. These materials offer moderate cost, can be punched when cold, and because of epoxies' tolerance for and reactivity with chlorinated compounds, are self-extinguishing. They offer unusual resistance to alkaline solutions used for plating copper circuit conductors with gold. Paper's economy and machinability are coupled with epoxy's superior electrical characteristics.

Wire Insulation Life Determined as a Chemical Reaction Rate Function

By E. L. Brancato and F. J. Campbell, U. S. Naval Research Laboratory.

Life versus temperature relationships of wire and cable insulations are needed to provide aircraft and missile engineers with information to design electrical circuits utilizing the minimum wire sizes required to maintain maximum reliability and yet reduce weight and bulk to a minimum. Thermal degradation of organic materials occurs as a chemical process, taking place as one or more of several general reaction types such as depolymerization, excessive cross-linking, or oxidation to form reactive and conductive acidic products. Through measurements of the effects of these reactions on physical and electrical properties, it is possible to apply chemical reaction kinetics, relating the deterioration rate with temperature under specified environmental and stress conditions. In the evaluation of electrical insulation, a practical measurement of life has been to set a limiting value of some electrical property as the criterion for the end of reliable life.

An expression relating this life to aging temperature as a straight line function was derived from the Arrhenius equation by Dakin in 1948. The final equation is often expressed in the form:

$$\log L = \frac{B}{T} + \text{constant}$$

where L = hours of life while aging at temperature T

T = absolute or Kelvin scale temperature

B = constant of the material related to the activation energy

This form has since been applied to aging data of many insulating materials to provide thermal stability classifications.

Experimental studies of aircraft insulation, employing the philosophy of functional evaluation and the principles of statistical distribution indicate that this expression can again be utilized. Plotting on semi-log paper, the least squares regression curve drawn through the experimental points obtained for one of these wires was illustrated in a figure. Four other types of wire utilizing the same insulating materials but differing in composite layer constructions yielded similar curves.

Since wires in service will probably be exposed to varying temperatures, an experiment was also conducted to verify the application of a relative aging factor formula to convert cyclic aging to equivalent aging at a single temperature. Calculated equivalent life points obtained from temperature cycling experiments were plotted with respect to the regression curve of this wire in another figure, thus verifying the application of this factor.

Letters to the Editor

"Your 'Opinions and Rambling Thoughts' in the April issue of *Insulation* are of interest to me. As a faculty member of the University of Cincinnati and Director of Research of the Cincinnati Development and Mfg. Co., whose principal product is insulation materials, the editorial seems especially appropriate for my consideration.

"As you probably know, there are more areas from which to draw material which is suitable for college courses than there is time available to teach these courses. Whereas one could argue that insulation engineering deserves to be taught because insulation is one of the basic components of any electrical system, this cannot be the criterion for including courses in a college curriculum. Rather the criterion seems to be that for any subject to serve as a basis for a course it must be developed to a point where the available unifying theory allows the information to be transmitted by mathematical concepts rather than descriptive material. This is a reasonable requirement in that it allows greater total transfer of information to the student.

"Now it is unfortunately true that in spite of our learning more about insulation the approach to most such problems is to make a judgment of the proper insulation to use by relying upon descriptive material. Even your publication *Insulation Engineering Fundamentals* indicates that my statement is correct. This well written book is largely descriptive and as such can be read by engineers on the job rather than taught in college. Until the unifying theory mentioned above is developed I see no hope of raising insulation engineering to the sophistication where it is a proper subject for college courses. Thus, rather than provide many of the things mentioned in your article it is first necessary to have the best theorist to place insulation engineering on a firm scientific basis and the results you desire will most likely follow."

—W. H. Middendorf, Associate Professor of Electrical Engineering, University of Cincinnati.

"As a project engineer of the Bendix Corporation, I receive the magazine *Insulation* regularly.

"The editorial in the April issue on 'Insulation Education' was of tremendous interest and, as a consequence, I would like to do something about education in the field of insulating materials.

"As a start, I would like to know if you have any bound copies of *Insulation* for the year 1960. Or, perhaps you could suggest some brochures or primitive texts in the insulation field.

"Personally, we here at Bendix are vitally interested in the effects of radiation on insulation and, as a result, we have amassed a great deal of information in this field. We believe that with our experience and library we are off to a good start. You are pioneering a good cause and we are with you."

—D. N. Hamilton, Project Engineer, Red Bank Division, The Bendix Corporation, Eatontown, N.J.

Thermocouple Calibration

Thermocouples are calibrated at the National Bureau of Standards over the temperature range of —190 to 1100°C. Depending on the material submitted, degree of accuracy required, and the temperature range covered, the thermocouples are compared with either standard resistance thermometers or standard platinum thermocouples, or calibrated at fixed points on the International Temperature Scale. Thermocouple materials — wires of various composition — are also calibrated, as are potentiometers. Standard samples of various metals are prepared as freezing point standards to aid other laboratories involved in thermocouple calibration.

Highlights of the National Plastics Conference and Exposition, June 5-9

Insulation men will find much of interest at the Ninth National Plastics Conference and Exposition in New York City, June 5-9. The event is sponsored by the Society of the Plastics Industry.

The exposition will be held in the Coliseum. An attendance of more than 30,000 is expected. More than 250 exhibitors from the United States, Canada, and Europe will exhibit a multitude of new plastic products, techniques, materials, and machinery. Every aspect of the plastics industry will be represented—molders, plastic film producers, raw materials suppliers, machinery and equipment manufacturers, and tool, die, and mold makers.

Displays will be open from 1 to 6 pm every day except Thursday, when the hours will be 1 to 9 pm. Advance registration is not necessary.

Conference sessions will be held Tuesday through Thursday, June 6-8, at the Hotel Commodore. All sessions will be held in the morning from 9 to 12 to avoid conflict with the exposition. Some of the main session topics are plastics in communications, plastics in machinery, thermoplastic structures, plastics in automotive, vinyl dispersions, epoxy applications, plastics in appliances, and plastics in defense. A listing of the papers in these sessions which may be of interest to *Insulation* readers will be found following this introduction.

Those wishing to attend the conference must register in the foyer of the Grand Ballroom at the Hotel Commodore. The registration desk opens at 1 pm, Monday, June 5.

Registration fees for the conference are $30 for SPI members and employees of member companies and $35 for non-members. This includes the $2 for the exposition and admission to the Industry Reception to be held Tuesday evening (6 to 8 pm) and a luncheon to be held on Wednesday (12:30 to 2 pm). Arrangements may possibly be made to reduce the fee for those who want to attend only one conference session.

The following is a partial conference program in which is listed selected papers which may be of interest to insulation men.

Tuesday—June 6

Plastics in Communications, East Ballroom — Moderator is J. V. McBride, The Plastic Wire & Cable Corp.

Plastic versus the Elements in Telephone Communications, by J. B. DeCoste and R. A. Connolly, Bell Telephone Laboratories Inc.

Plastics in the Space Environment, by Eric Linden, Fort Monmouth Civilian Signal Communication Laboratories.

Plastics in Radio, Television and Computers, by James Lampman and Ray Shirk, General Electric Co.

Plastics in Machinery, West Ballroom —Moderator is A. J. de Matteo.

New Development in Machinery for the Thermoforming Industries, by W. C. Schlager, U.S. Rubber Co.

New Developments in Blow Molding Machines, by R. Boyden, F. J. Stokes Corp.

New Developments in Injection Molding Machines, by James W. Hendry, Borg-Warner Corp.

New Developments in Extruders, by Albert A. Kaufman, Prodex Corp.

Thermoplastic Structures, Windsor Ballroom.

Color Movie—The Manufacture and Fabrication of Polyolefins in Europe, courtesy of the Hoechst Co.

Manufacture of Thermoplastic Structures, by Donald Wolff, Seiberling Rubber Co.

Wednesday—June 7

Plastics in Automotive, East Ballroom.

Current Uses and Requirements, by Thomas H. Risk, Ford Motor Co.

The Purchasing Agent Looks at Plastics, by Jack Moran, Chrysler Corp.

The Role of the Processor, by John S. O'Connell, Consolidated Molded Products Corp.

Panel Discussion and Question and Answers, by John Young, E. I. du Pont de Nemours & Co. Inc.; John Slater, Eastman Chemical Products Inc.; Jack Doyle, Rohm & Haas Co.; and Harry McGowan, Union Carbide Plastics Co.

Vinyl Dispersions, Windsor Ballroom —Introduction of speakers by Frank W. Caplan, Reynolds Chemical Products Co.

General Introduction to Vinyl Dispersions, by Donald R. Meserve, Metal and Thermit Corp.

Uses of Vinyl Dispersions—Present & Future, by Robert T. Henson, Flexible Products Co.

Role of Custom Formulator in the Vinyl Dispersions Industry, by Robert F. McTague, The Stanley Chemical Co.

Panel—Speakers plus Russell Park, Firestone Plastics Co., and David H. Bechtold, Monsanto Chemical Co.

Epoxy Applictions, West Ballroom—Moderator is Donald Roon, Hysol Corp.

Adhesives, by Bernard Gould, Rubber & Asbestos Corp.

Electrical, by John Delmonte, Furane Plastics Inc.

Tooling, by Charles Douglas, Marblette Corp.

Luncheon (12:30 to 2 pm), Grand Ballroom.

International Reception (6 to 8 pm), United Nations Headquarters.

Thursday—June 8

Plastics in Appliances, Grand Ballroom—Moderator is Gordon Thayer, Dow Chemical Co.

Designing Appliances for Functional Performance, by Carl W. Sund-

G-E Fusa-Fab: EASY-TO-USE, VERSATILE, RUGGED, and ECONOMIC

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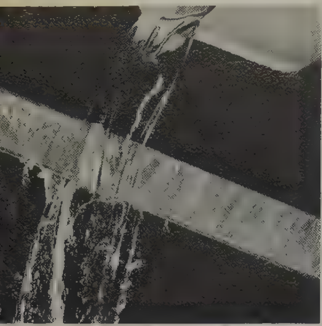

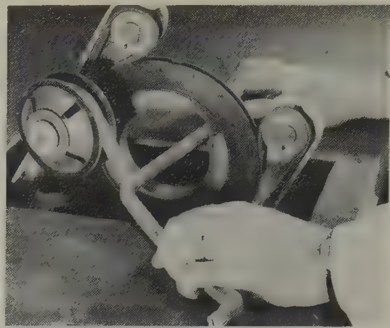

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berg, Sundberg & Ferar.

What the Appliance Industry Feels It Needs in the Way of Plastics Materials and Services, by William Gobeille, American Motors Corp.

Plastics in Defense, East Ballroom—Moderator is John K. Honish, Union Carbide Plastics Co.

Plastics in Weapons, by Albert Lightbody, U.S. Naval Ordnance Laboratory.

Plastics in Over-all Defense, by Paul Forsyth, OSD-DDR & E.

Plastics in Space & Missiles, by Victor N. Saffire, Missile & Space Vehicle Div., General Electric Co.

Missile Relies on Reinforced Plastic

Reinforced plastic parts are helping insure high performance in the RP-76 rocket-powered target missile employed by the U. S. Army to test its surface-to-air weapons systems.

The drone's plastic nose and aft fuselage sections give lightweight strength that helps make ground recovery possible when the target is not intercepted in flight. Molded from glass cloth (prepregs) impregnated with "Dapon" diallyl phthalate resin (Food Machinery and Chemical Corp.), the parts are attached to the steel case housing the solid-propellent rocket engine.

The plastic parts also provide unusual weathering protection and resistance to the extreme temperatures (above 200°F) encountered at supersonic speeds. Outstanding electrical properties make the plastic material transparent to radar beams, thus permitting unobstructed reflections from the Luneberg radar augmenter installed in the nose of the drone. Missile contractor is the Radioplane Division of Northrop Corp.

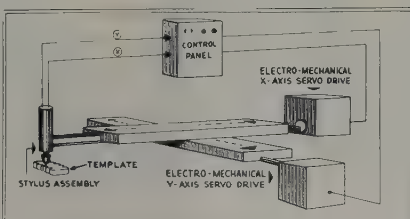
The diallyl phthalate reinforced glass cloth — Mobaloy D prepregs supplied to Radioplane by Cordo Chemical Corp. — is reported to offer decided production advantages. Made tacky to facilitate hand lay-up for match-die molding, it has good drape and excellent resin flow during curing. The maroon color of the parts is incorporated with the color-stable Dapon resin in the prepreg, thereby eliminating the need for painting finished sections.

Print Ins. 19 on Reader Service Card for General Electric Co. ad above.

Tracer System Shapes Porcelain Insulators

Complete automation of turning operations in the production of porcelain insulators reportedly is accomplished by a two-dimensional tracer system. A prototype machine developed by Seneca Falls Machine Co., Seneca Falls, N. Y., is said to triple the productive capacity of one man and improve the quality of work.

The system is electro-mechanically controlled and will follow any contour around a 360° path at a constant cutting speed—regardless of direction. The value of the cutting speed can be varied manually, or can be automatically controlled as a function of spindle speed to maintain a constant feed rate in inches per revolution of the spindle.



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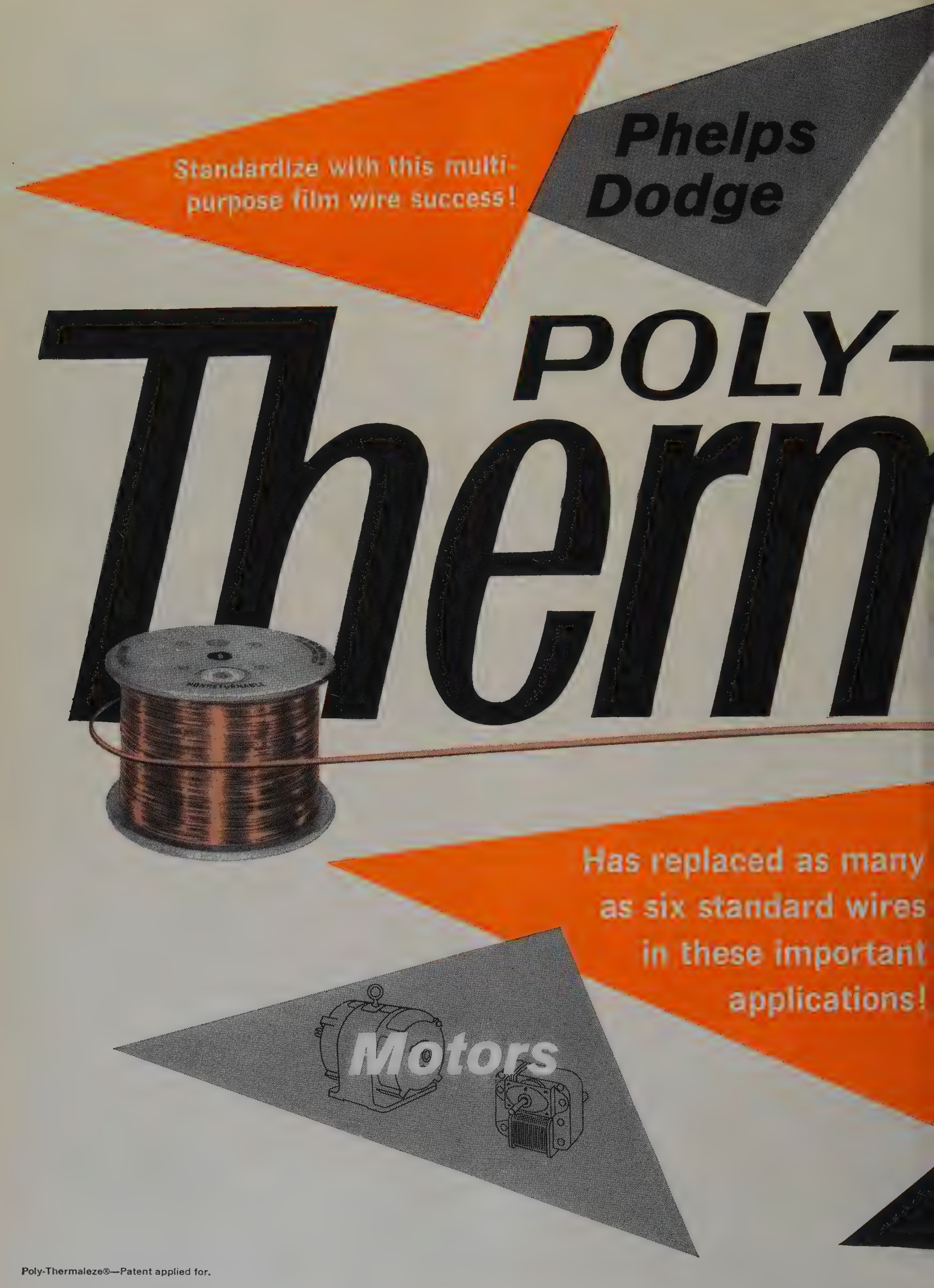
The tracer system incorporates a patented rotating eccentric stylus design. Critical assemblies are eliminated and the need for adjustment is minimal. The stylus assembly on contact with the template, which conforms with the contours to be cut into the porcelain insulator, continuously feeds electric signals to X and Y axis servo drives. These low powered signals are boosted to actuate a servo motor, which controls table and cutting movement for any value of the X and Y coordinate axes. The two dimensional tracer is available in a package and may be applied to existing equipment.

Print Ins. 20 on Reader Service Card



Poly-Thermaleze®—Patent applied for.

New Publications

Books

Electronic Packaging with Resins: A Practical Guide for Materials and Manufacturing Techniques by Charles A. Harper. Covers casting, potting, impregnation and encapsulation of electrical and electronic components and systems in excellent detail. Materials discussed include epoxies, polyesters, silicones, urethanes, polysulfides, and many others. Modifiers are treated, and many different materials classes are included, such as foams, low density systems, high thermal and electrical conductivity compounds, environmental resistant systems, flame retardant resins, high-temperature resins, and the new epoxy systems such as novolacs, cycloaliphatic diepoxides, and epoxidized polyolefins. In addition, there are chapters on tools, fixtures, processing equipment, curing, testing methods, and manufacturing controls. 360 pages, 6″ x 9″, $11. McGraw-Hill Book Co., 330 W. 42nd St., New York 36.

Standards & Specifications Documentation Symbols & Abbreviations, by John T. Milek. Contains approximately 500 symbols and abbreviations to aid design engineers, draftsmen, specification writers, standards engineers, and others using standards and specifications documents. 14 pages, $1.50. Standards Press, 8417 Reading Ave., Los Angeles 45.

Plastics, the Story of an Industry. Booklet provides basic information about the industry's growth, raw materials, typical end uses with illustrations, properties, methods of processing, and fabricating. It includes a brief history, and a reference to educational facilities. 44 pages, $1. The Society of the Plastics Industry Inc., 250 Park Ave., New York 17.

Guide to U.S. Government Statistics. Revised and enlarged edition. Hard cover, 402 pages, $15. Documents Index, Box 453, Arlington 10, Va.

Thermophysical Properties of Solid Materials. A five-volume handbook on elements, alloys, ceramics, cermets, intermetallics, polymerics, and composite materials. Except for materials in the last two categories, only those melting above 1000°F are included. Approximately 4000 pages. Order WADD Technical Report 58-476 from the Macmillan Co., 60 Fifth Ave., New York, N. Y.

Advances in X-Ray Analysis, Volume 4. Contains the complete texts of 38 reports presented at the Ninth Annual Conference on Applications of X-Ray Analysis. Illustrated, 576 pages, $15. Plenum Press Inc., 227 West 17th St., New York 11.

1960 Supplements to Book of ASTM Standards. The 1960 supplements give in their latest form standard specifications, tests, definitions, and recommended practices which are being issued for the first time or which have been revised since their appearance in the 1958 Book of Standards. There are 10 parts. Those of interest to *Insulation* readers are: Part 2, *Non-Ferrous Metals Specifications and Electronic Materials;* Part 5, *Masonry Products, Ceramics, Thermal Insulation, Acoustical Materials, Sandwich and Building Constructions, Fire Tests;* Part 6, *Wood, Paper, Shipping Containers, Adhesives, Cellulose, Leather, Casein;* Part 7, *Petroleum Products, Lubricants, Tank Measurement, Engine Tests;* Part 8, *Paint, Naval Stores, Coal and Coke, Aromatic Hydrocarbons, Gaseous Fuels, Engine Antifreezes;* Part 9, *Plastics, Electrical Insulation, Rubber, Carbon Black*, and Part 10, *Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes*. $4 per part. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Physical Gas Dynamics, edited by A. S. Predvoditelev. The proceedings of a symposium devoted to work carried out in the Power Engineering Institute of the Academy of Sciences of the USSR. Part of the symposium covered an investigation of the hydrodynamic phenomena accompanying electrical discharges in water. 189 pages, 9½″ x 6⅛″, $7.50. Pergamon Press Inc., 122 East 55th St., New York 22.

Gases at High Densities and Temperatures, edited by Yu. N. Ryabinin. Translation of a Russian investigation involving the production of high pressures and temperatures in gases by isentropic compression. Thermodynamic characteristics, radiation spectra, and electrical conductivity of the compressed gases were studied. Illustrated, 60 pages, 8½″ x 5½″, $4.50.

Advances in Cryogenic Engineering (Volume 6), edited by K. D. Timmerhaus. Contains 65 papers presented at the 1960 Cryogenic Engineering Conference. Illustrated, 652 pages, $15.

Oersted and the Discovery of Electromagnetism, by Bern Dibner. This is the latest in a series of monographs on milestones in the history of science. 48 pages, $2. Burndy Library, Norwalk, Conn.

ASA Publications

The following publications may be obtained from the American Standards Association, 10 East 40th St., New York 16.

IEC Publications Listing. Lists all International Electrotechnical Commission publications through December 1960. It contains a summary of the contents of each IEC publication as well as an alphabetical index. 60 cents.

Report of IEC 1960 General Meeting. Report of the U.S. National Committee of the International Electrotechnical Commission details the activities of the various subcommittees and efforts of the 35 member nations toward standardization at the 1960 general meeting. 17 pages. Free.

IEC Publication 117-2, Recommended Graphical Symbols. Specifies the 78 recommended graphical symbols for machines, transformers, primary cells and accumulators. 30 pages, $2.40.

American Standard Specification

Varmat is the newest addition to the famous Vartex line of quality tapes . . . designed especially for use where exceptional resistance to moisture is essential. A low power factor tape, Varmat also offers you high heat resistance and high dielectric strength. It can be slit to any width and is ideal for wrapping. Typical applications include coil windings and cable splicing. Varmat is supplied coated with black or yellow varnish or *other* moisture- and high heat-resistant coatings.

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Earl B. Beach Co., Pittsburgh, Pa.
Phila. (Clifton Heights) Pa.
Brooks Electrical Supply Co., Inc., Baltimore, Md.
John H. Cole, Company, Oklahoma City, Okla.
Electrical Insulation Sales Co., Rutherford, N. J.
Electrical Insulation Suppliers, Inc., Atlanta, Ga.
Electric Motor Supply Company, Denver, Colo.
Hanna & Ferguson, Rochester, N. Y.
Hippler Sales Company, Webster Groves, Mo.
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Special combinations available upon request

**Mylar, Du Pont's registered trademark †Fiberglas, Owens-Corning Fiberglas registered trademark*

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for General-Purpose Sound-Level Meters, S1.4-1961. $1.30.

The Executive Viewpoint on Standards. Contains five papers presented at the 1960 national conference on standards. $1 for non-members and 50 cents for members.

C8.37-1960, American Standard Specification for Ozone-Resisting Butyl Rubber Insulation for Wire and Cable (ASTM D1352-60). 30 cents.

C8.38-1960, American Standard Specification for Synthetic Rubber Heat or Moisture-Resisting Insulation for Wire and Cable (ASTM D1520-60). 30 cents.

C8.39-1960, American Standard Specification for Synthetic Rubber Performance, Moisture-Resisting Insulation for Wire and Cable (ASTM D1521-60). 30 cents.

C8.40-1960, American Standard Specification for Synthetic Rubber Insulation for Wire and Cable, 90°C Operation (ASTM D1523-60). 30 cents.

C8.22-1960, American Standard Methods of Testing Rubber and Thermoplastic Insulated Wire and Cable (ASTM D470-59T). 60 cents.

C8.28-1960, American Standard Specification for Styrene-Butadiene (SBR) Synthetic Rubber Sheath for Wire and Cable (ASTM D866-58). 30 cents.

C8.32-1960, American Standard Specification for Heavy-Duty Black Neoprene Sheath for Wire and Cable (ASTM D752-60). 30 cents.

C8.31-1960, American Standard Specification for General Purpose Neoprene Sheath for Wire and Cable (ASTM D753-60). 30 cents.

C8.27-1960, American Standard Specification for Natural Rubber Heat-Resisting Insulation for Wire and Cable, 75°C Operation (ASTM D469-58). 30 cents.

C8.26-1960, American Standard Specification for Natural Rubber Performance Insulation for Wire and Cable, 60°C Operation (ASTM D353-58). 30 cents.

C8.23-1960, American Standard Specification for Synthetic Rubber Insulation for Wire and Cable, 60°C Operation (ASTM D755-58). 30 cents.

C8.24-1960, American Standard Specification for Synthetic Rubber Insulation for Wire and Cable, 75°C Operation (ASTM D754-58). 30 cents.

C8.29-1960, American Standard Specification for Ozone-Resisting Insulation for Wire and Cable (ASTM D574-59T). 30 cents.

C8.25-1960, American Standard Specification for Natural Rubber Sheath for Wire and Cable (ASTM D532-58). 30 cents.

C29.1-1961, American Standard Test Methods for Electrical Power Insulators. $1.50.

Power Switchgear Standardization Report. Prepared by the ASA Sectional Committee C37 on Power Switchgear, it details the activities in the switchgear standardization field over the past 15 months. Free.

IEC Publication 50(50). Contains terms and definitions used in electrochemistry and electrometallurgy. (Group 50 of the Second Edition of the International Electrotechnical Vocabulary.) $4.80.

NEMA Standards

The following listed standards publications may be obtained from the National Electrical Manufacturers Association, 155 East 44th St., New York 17.

CP1-1961, Shunt Capacitors. 60 cents.

IC 3-1961, Precision Snap-acting Switches. 35 cents.

MW 5, Single, Heavy and Triple Polyester Coated Round Copper Magnet Wire. 35 cents.

MW 7, Ceramic Silicone Coated Round Copper Magnet Wire. 35 cents.

MW 8, Ceramic Polytetrafluoroethylene Coated Round Copper Magnet Wire. 35 cents.

MW 10, Single, Double, Triple and Quadruple Polytetrafluoroethylene Coated Round Copper Magnet Wire, 35 cents.

PH 1-1960, Spool-type Secondary Racks. 40 cents.

SM 40-1961, Marine-propulsion Steam Turbines and Gears. $2.

VU 1-1961, Vulcanized Fibre. 60 cents.

240-1961, Test for Flame Resistance of Laminated Sheets or Cast Insulating Materials. 25 cents.

Industry News

Consolidated Electrodynamics Corp., subsidiary of *Bell & Howell Co.*, Pasadena, Calif., is now marketing its "Ceramicite" glass-to-metal hermetic seal through its connector products manufacturing representatives. The connector products have been established as the third major product line of the newly formed *Data Recorders Division.*

Construction of a new sales office and warehouse to handle electrical insulating materials made by *Minnesota Mining and Manufacturing Co.* has begun in Needham, Mass.

Electronic Mechanics Inc., Clifton, N.J., says its new mica manufacturing facility will have a production capacity of 500 tons annually.

A $500,000 polycarbonate product and process development laboratory being built by *General Electric Co.* at Mt. Vernon, Ind., is expected to be completed by July.

Radar Relay Inc., Santa Monica, Calif., has created a new division called *Ratronics* to handle its printed circuitry activities.

Loral Electonics Corp., New York City, is negotiating for the acquisition of *Accurate Specialties Co., Inc.*, Hackensack, N.J., producer of high purity metals and ceramics for electronics.

General Electric's Silicone Products Department has established a second Texas sales office and warehouse in Houston. The other one is in Dallas.

Hercules Powder Co. has begun construction of a new plant at Hopewell, Va., which will manufacture hydroxyethylcellulose. Its new multimillion dollar polyolefins plant in Lake Charles, La., was dedicated on April 6th.

Tensolite Insulated Wire Co. Inc., Tarrytown, N.Y., has established a new sales office in Los Angeles to service customers in California, Arizona, and Nevada.

Hynes Electric Heating Co., Mountainside, N.J., has moved to a new plant in Kenilworth, N.J.

United Technical Industries Inc. is completing a new beryllium oxide manufacturing plant at Delta, Utah.

A new Aero-Space Computer Section has been formed in Willow Grove, Pa., by *Philco Corporation's Computer Division.*

Sylvania Electric Products Inc., subsidiary of *General Telephone & Electronics Corp.*, has opened a 19,600 sq ft controlled environment "white room" in Buffalo, N.Y.

Wabash Magnetics, Inc., is the new name of *Deluxe Coils Inc.*, resulting from completion of the merger into Deluxe of *Western Hemisphere Petroleum Corp.* Plants are in Wabash and Huntington, Ind.

Diebel Die & Mfg. Co., electrical component manufacturer, has moved to a new location in Morton Grove, Ill.

Astrosonics Inc., Syosset, L. I., N. Y., has created a new division called *Astrosonic Development Laboratories* to do contract research and development.

Hyres Electrical Division has been formed by *Hydraulic Research and Manufacturing Co.*, Sun Valley, Calif., to manufacture electronic components for aerospace programs.

New departments at *Hercules Powder Co.*, Wilmington 99, Dela., are Synthetics, Cellulose and Protein Products (formerly Virginia Cellulose), and Polymers (formerly Cellulose Products). General managers of the departments are: Polymers, Warner C. Brown; Cellulose and Protein Products, Edward G. Crum; and Synthetics, Donald H. Sheffield.

Elco Electronics Inc., Michigan City, Ind., manufacturer of portable and console phonographs, has been acquired by *Telex Inc.*, Twin Cities (Minn.) electronics firm.

General Electric Co. plans to make a $750,000 expansion in its phenolic molding compound plant in Pittsfield, Mass., The 30 percent increase in plant capacity is expected to be operational in 1962.

Atlantic Research Corp., Alexandria, Va., has acquired about 15% ownership of *Nuclear Science and Engineering Corp.*, Pittsburgh, Pa.

Clark-Schwebel Fiber Glass Corp. has started production at its new

$3,500,000 fiber glass weaving and finishing plant in Anderson, S. C.

Irvan Engineering Co. Inc. has formed a new division, the *Irvan Ferrite Corp.*, for the manufacture of ferrite for electronic applications. About 4,000 sq ft of manufacturing facilities will be added to *Irvan's* plants in Van Nuys, Calif.

Reynolds Metals Co. has purchased the *Ford Motor Co.* building and plant at Chester, Pa., for $2,200,000. The 650,000 sq ft of floor space will be used to manufacture insulated wire and cable products.

Temptron Inc., Reseda, Calif., has doubled the size of its manufacturing

facilities with the addition of a 10,000 sq ft swaging facility costing nearly $100,000.

Temperature Engineering Corp., Riverton, N. J., producer of infrared ovens, environmental control systems, and related equipment, has agreed to purchase the *Jacksonville Metal & Plastics Co.*, Jacksonville, Fla. The new plastic molded parts division will be renamed *Jaxco Jetronics Corp.*

Accurate Electronics Corp., Elyria, Ohio, has appointed the *K. W. Lockwood Co.*, Los Angeles, to represent its terminal boards and associated components in southern California and southern Nevada.

Bucky Harris Co., Los Angeles, has been appointed West Coast representative for the "Teflon" and vinyl insulated wire and cable manufactured by *Thermatics Inc.*, Elm City, N. C.

Chicago Standard Transformer

SILICOLOGY *Studies in Silicones*

HOW THESE TIME-TESTED MATERIALS CAN WORK FOR YOU

Versatile Rubber Compound Serves For Many Types of Insulation

L. Frank Markel & Sons, Norristown, Pa., has added UNION CARBIDE K-1347 Silicone Rubber Compound to the list of carefully selected materials used in the fabrication of its broad line of products, which include extruded tubings, insulated wire, and coated braid sleevings.

Selection of the versatile material with a combination of properties not found in any other single silicone rubber compound, followed searching discussion with the UNION CARBIDE Silicones Man of the requirements to be met.

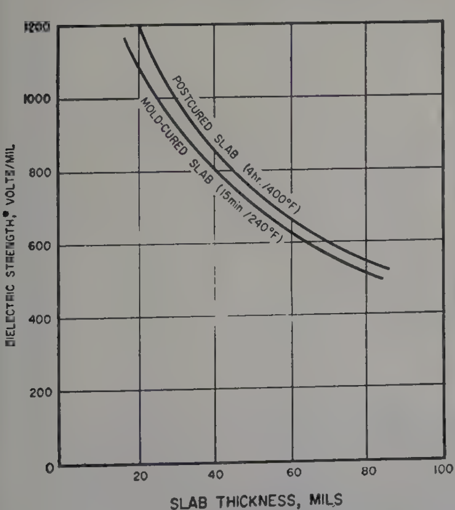
Besides the economy of convenience, the company reports that K-1347 has enabled them to maintain their high quality standards. Customers, moreover, have reacted favorably to the physical and electrical properties of the finished material.

EXCELLENT PROCESSIBILITY

Originally developed as a premium quality compound for extruding, calendering, and molding, K-1347 in testing exhibits superior physical properties—high tensile (1400 psi after 10 minutes' molding cure at 240°F), tear, and elongation—and excellent electrical properties as well *(see graph)*.

When extruded onto wire and cured in hot air or steam, K-1347 satisfies military specifications MIL-W-19381, MIL-W-8777, and MIL-W-16878 (F&FF). Shrinkage in mold-curing is less than 2.5%, in postcuring less than 3.6%. The compound is normally supplied white or clear, but it can be easily colored to desired shades.

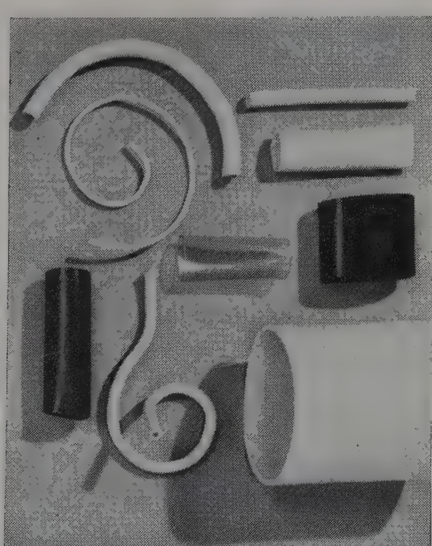
Dielectric Strength vs. Thickness "UNION CARBIDE" K-1347 Silicone Rubber



*ASTM D149-59: Constant Rate of Rise. ¼" Electrode in 74°F. Air.

OTHER FABRICATOR REPORTS

Another customer/fabricator, using K-1347 in "spaghetti" sleeving, is reported saying, "Physical properties are fine . . . testing of sleeving gave readings over 1100 volts per mil on 13.5 mil wall thickness . . ." A third customer recently extruded K-1347 onto 15 mil electrical tubing. Dielectric breakdown, measured via ASTM D149-59 method, was 14,900 volts compared with competitive product's 7,000 volts (approximate).



A FEW OF THE MANY quality Silicone Rubber electrical insulation products fabricated by L. Frank Markel & Sons, Norristown, Pa.

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COMPOUNDS PASS FLAME TEST

Both UNION CARBIDE Compounds K-1347 and K-1357 pass the flame test on wire called for in spec Mil W-16878. The test requires applying a Bunsen Burner flame to a sample of wire for 30 seconds. The wire is suspended in a position 45° from the horizontal. The flame is applied at the lower of two marks on the wire 6 inches apart, and length of flame travel and burning time are observed. Specification calls for a maximum of 3 inches of flame travel and 30-second burning time.

Experiment with K-1347 in your products—and be surprisingly rewarded—next time you have an appropriate application where superior physical and electrical properties are important, and where you could really save with ease of fabrication and handling. Send the coupon for further information.

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Corp. has changed its name to *Stancor Electronics Inc.* In addition to existing facilities in Chicago and Zanesville, Ohio, *Magnetic Windings*, with plants in Easton and Gettysburg, Pa., will be consolidated into the Stancor organization.

The Sprague Electric Co., North Adams, Mass., is consolidating all resistor manufacturing, engineering and marketing activities in a new Resistor Division to be headed by Richard K. Morse.

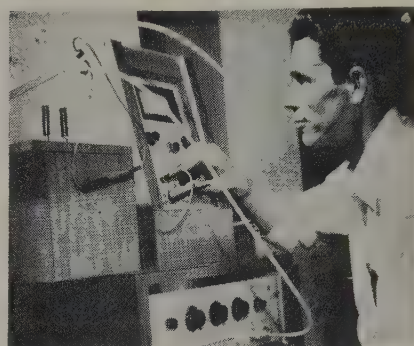
Herman H. Smith Inc., Brooklyn, N. Y., electronics components manufacturer and distributor has acquired an additional 14,000 sq ft of space for manufacturing and warehouse use.

The Aro Equipment Corp., Bryan, Ohio, plans to change its name to *The Aro Corp.*

The *Relay Div.* of the *Fred Goat Co.*, Brooklyn, N. Y., has been purchased and re-organized as a new firm called *Goat Electronics Inc.* New owners are Paul Sheerer Jr., president: Stuart Miller, treasurer; John McMahon, vice president—sales; and John Vetrano, chief engineer.

Associated Testing Laboratories Inc., Wayne, N. J., has opened an environmental testing laboratory in Burlington, Mass. The 13,500 sq ft building will provide testing and reliability studies for aerospace and electronics manufacturers.

Voltmeter-ammeter testing equipment has been added to the process



engineering facilities of *Formica Corp.*, Cincinnati, Ohio, to check electrical grades of its industrial laminates.

Diamonite Products Mfg. Co., Shreve, Ohio, has appointed the *Harry G. Lake Co.*, Dayton, Ohio, to sell its high alumina technical ceramic parts and components to the electronic and related industries.

The Electronics Div. of *Chance Vought Corp.*, Dallas, Texas, recently opened a new $3,500,000 facility in the Great Southwest Industrial District near Arlington, Texas.

Chicago Magnet Wire Corp. has appointed the *Mel Foster Co.*, Minneapolis, Minn., as its representative for the Minneapolis-St. Paul area.

Clevite Corp., McConnelsville, Ohio, expects to complete doubling of its capacity for the production of electrolytic copper foil used in printed circuits by October.

A new *Military Electronics Division* has been established at Redondo Beach, Calif., by *Bogue Electric Mfg. Co.*, Paterson, N. J.

Philco Corp. recently opened a new 45,000 sq ft building in the Fort Washington (Pa.) Industrial Park to house its expanding *Communications Systems Divisions.*

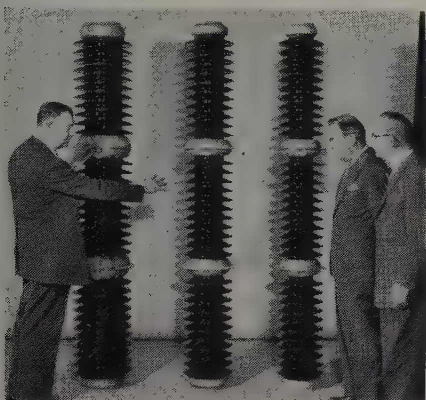
The M & T Co., Philadelphia management engineering firm, has acquired additional office space in the Valley Forge Center Inc., in King of Prussia, Pa.

Print Ins. 26 on Reader Service Card

Electrostatic Deflectors In Tall Insulator Stacks

New electrostatic rain deflectors, the small metal shields between the insulator caps in the photograph, use the electrostatic field surrounding the insulator to disperse falling rain water, directing and actually propelling it away from the insulator. The principle is said to work equally well to eliminate flooding under heavy rain or trickling of contaminated water under light rain or drizzle.

Tall insulators with deflectors reportedly produce as high wet flashover efficiency as do shorter posts without them. The deflectors are small in diameter to allow uniform wetting of the entire fog-type insulator with-



out producing dry sections under the deflectors as would large hoods or shields. Uniform wetting is desirable to equalize electrical stress, minimizing local hot spots where arcing could develop.

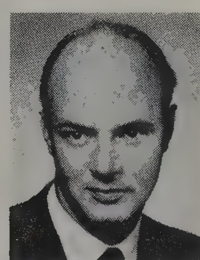
High voltage station posts rated at 900, 1050, 1300, and 1470 kv, BIL and higher with the new electrostatic rain deflectors are supplied by the Insulator Div., Lapp Insulator Co. Inc., Le Roy, N. Y. The addition of the electrostatic deflectors to the basic station post design is claimed to make the insulators particularly suited to high voltage and EHV applications.

The sports car owner's description of the U.S. standard automobile: "It's a 4-eyed, 2-horned, pink and purple ethyl eater." *"By Gum" Reichhold Chemicals, Inc.*

Insulation Forum

This regular monthly feature is built around a timely question concerning the electrical insulation field. Your suggestion for future questions and participation are invited. This month's question is:

In general, what are your thoughts regarding international competition in the American market for electrical/electronic products? For example, are you in favor of, or against, such competition—if you are against it, how do you think it should be handled—if you are for it, what steps do you think should be taken to encourage both imports and exports? Are you aware of any specific inroads being made by equipment or insulation materials produced in countries other than the USA?



K. M. Miller

Vice President and General Manager, Daystrom Inc., Pacific Div., Los Angeles.

"America is an international leader because we thrive upon competition. Fair competition must always exist since it is a primary motivation in achieving progress. Today's level of international competition is the outgrowth, in part, of America's generosity in sharing her technological knowledge on a world-wide basis.

"An accelerated monitoring program must be implemented to assure us that our proprietary techniques and processes, when used by foreign manufacturers, result in equitable reimbursement to the originator. Our tariff laws are antiquated. Many are unilateral in concept. Both of these are secondary control devices. The significant leveling effort will come into play at an accelerated pace as we develop major advancements in automated production of basic materials and end products. This shall reduce the labor input to an insignificant portion of the total cost to manufacture a product. Only when this occurs will America resume a dominant role in international trade."

R. T. Hejduk

Senior Buyer, Jack and Heintz Inc., Cleveland, Ohio.

"To date, we have not purchased items outside the continental limits of the United States. Our sales volume normally has 80% of its dollar tied directly to defense contracts which require us to respect the Buy American Act. However, even with this limitation, we have found our past dealings with the major insulation manufacturers to have been most satisfactory.

"A pressing problem regarding international competition, still to be solved to the satisfaction of the insulation buyer, is a lack of clear understanding in the procedures to be followed when handling rejected materials. This problem is bound to arise, yet few foreign suppliers have come forth with concrete suggestions as to how this is to be handled. The manner in which this situation is solved will greatly affect future business dealings with foreign sources."

Mass Translation

The Soviets employ over 2000 full-time and 20,000 part-time workers who abstract and translate technical articles from the outside world and have them ready for Russian scientists about 4-6 months after initial publication. Best U. S. counterpart system has only 1700 part-time workers, takes a year to prepare foreign articles for scientific study. (Source: Research in Government and Industry, by General James M. Gavin, American Institute of Chemists, May 7, 1959.)

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Association News

Meeting on High Precision Connectors

A one-day meeting on high precision connectors will be held on June 29, 1961, at the Boulder Laboratories of the National Bureau of Standards, Boulder, Colo.

The objective of the meeting is to reduce those errors in precision measurements which are due to connector uncertainties in coaxial equipment at radio and mirowave frequencies. It is expected that this can be achieved by agreement on design, size, tolerances, etc., of a minimum number of connectors which will be used by standardizing laboratories and incorporated in manufactured instruments capable of high precision. The morning will be devoted to papers giving quantitative information on high precision connectors and the afternoon to a round table discussion on the same topic.

Papers and discussion are invited on related subjects including dielectric material for supports in connectors.

Abstracts of paper should be submitted by May 1, 1961, to R. C. Powell, National Bureau of Standards, Boulder, Colo.

Paper on Film Degradation Included in ASHRAE Meeting

The 68th annual meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) will be held June 26-28 at the Denver Hilton Hotel, Denver, Colo.

The program features a series of three technical sessions, four symposiums, forums, and committee meetings. Among the 15 papers to be presented at the technical sessions will be one on Degradation of "Mylar" Film Exposed to Water and Alcohol.

NEC Calls for Papers

Papers on components, devices, design, techniques, applications, management, etc., are requested for presentation at the 17th annual National Electronics Conference, International Amphitheatre, Chicago, Oct. 9-11.

Two $500 awards will be given: one for the best overall paper and one for the best tutorial paper.

Papers should be submitted to W. L. Firestone, Motorola, Inc., 4501 W. Augusta Blvd., Chicago 51.

New Officers for AWS

New officers elected at the recent annual meeting of the American Welding Society are: A. F. Chouinard, National Cylinder Co., president; and Jay Bland, General Electric Knolls Atomic Power Laboratory, vice president.

Electrical Insulation Conference At Pocono Manor Oct. 23-25

The 1961 Conference on Electrical Insulation will be held at Pocono Manor Inn, Pocono Manor, Pa., on Oct. 23-25 (Monday-Wednesday). The annual meeting is sponsored by the Division of Engineering and Industrial Research, National Academy of Sciences-National Research Council.

S. I. Reynolds, General Electric Co., is chairman of the conference. The secretary of the conference, Joseph Sticher, Detroit Edison Co., is in charge of the local arrangements.

The chairman of the program committee, Philip J. Franklin who is also conference vice chairman, is soliciting technical papers. He requests that titles and abstracts of about 100 words be sent to him by August 1 at the Components Laboratory, Diamond Ordnance Fuze Laboratories, Washington 25, D. C. In addition, symposiums will be held on the subjects of "Electrolytic Conductance," and "Fundamental Properties of Dielectrics." Also, round table discussions will be held on Monday evening.

Registration and membership fees will be the same as last year. Members receive the Annual Report of the Conference and the Annual Digest of the Literature on Dielectrics for the combined registration and membership fee of $10. The registration fee for non-members is $5 and does not include publications. There is no fee for students.

EASA Meets June 11-14 In San Francisco

The 28th Annual Convention of the Electrical Apparatus Service Association Inc. will meet June 11-14 at the Jack Tar Hotel, San Francisco. It is expected that 1,500 EASA members, exhibitors, and members of their families will attend.

The convention will open on Sunday night with a reception for EASA president J. Arthur Turner Jr., Tampa (Fla.) Armature Works. One night has been set aside for exhibitors, and a tour of electric apparatus service shops in the Bay area has been arranged. There will be a separate program for women guests.

Members of the convention committee are: William S. Bassett, Conrad Electric Co., entertainment chairman; Dick Gardner, Electrical Specialty Co., Tom Stahlbaum, Tri-State Supply Corp., Al Eckdall, Insulation & Wires, Inc., and Leo Alchimistri, Advance Carbon Co., information committee; Al Dutil, Enterprise Electric Works, transportation chairman; Alfred Kinney, Kinney Electric Co., exhibits chairman; Frank Silveria, hospitality chairman; and George Larsen, Larsen-Hogue Electric Co., EASA president-elect, program chairman.

Registrations and requests for hotel reservations should be directed to EASA headquarters, 7730 Carondelet Ave., St. Louis 5, Mo.

Insulation, Other Topics In AIEE June Meeting

The annual Summer General Meeting of the American Institute of Electrical Engineers will be held at Cornell University, Ithaca, New York,

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Now, a new magnet wire enamel formulation based on FORMVAR resins sets a new standard of performance in hermetic units. Proved in the field as well as the laboratory, the new formulation maintains the unequalled physical and chemical properties of a standard FORMVAR-with-phenolic enamel and also offers these important features:

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2. Formetic based wire enamel has excellent mechanical characteristics for improved windability.
3. Maximum insolubility in almost all conventional solvents.
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June 18-23. It is expected that 2,000 engineers, industrialists, and educators will attend.

The meeting will begin Monday with the announcement of new officers. The technical program will consist of 58 sessions and symposiums in the field of electrical engineering and allied arts.

Education in electrical insulation will be the subject of one session being co-sponsored by the Committees on Electrical Insulation and Education. Graham Lee Moses, Westinghouse Electric Corp., will preside over this session which begins at 2 pm on June 21.

The following papers will be presented: Opportunities for Electrical Engineers in the Field of Electrical Insulation, by K. N. Mathes, General Electric Co.; What the Colleges are Teaching about Dielectrics and Insulation Fundamentals, author to be announced; The Need for Research in Insulating Materials, by J. Swiss, Westinghouse Electric Corp.; Industry's Outlook on Education in Dielectrics, by J. R. Perkins, E. I. du Pont de Nemours & Co. Inc.; Outline for a Proposed Course in Insulation Fundamentals, by M. L. Manning, South Dakota State College.

Other AIEE News

Two new sections have been formed by the American Institute of Electrical Engineers. One is the North Alabama Section, with H. F. Rees as chairman and E. O. Berg as secretary. The other is the Hampton Roads Section in Virginia. Officers are Draper D. Smith, chairman, and Twyman E. Bowman, secretary.

New officers elected by the New York Section include: J. C. Hoyt, chairman; W. G. Cheney, vice chairman; A. E. Joel, secretary; and S. H. Grim, treasurer.

Change Name, Request Papers for Insulation Application Conference

The name of the National Conference on the Application of Electrical Insulation has been changed to Electrical Insulation Conference. The fourth national conference will be held at the Shoreham Hotel, Washington, D.C., on February 18-22, 1962. Technical sessions will start on Tuesday, February 20.

Papers are being solicited and abstracts or summaries of proposed papers should be sent to the general program chairman, J. S. Hurley Jr., General Electric Co., Waterford, N.Y. All papers will be published in a conference booklet.

Vice chairmen of the four program divisions are: Electronics Division, T. D. Callinan, International Business Machine Co.; Distribution and Transmission Division, J. R. Meador, General Electric Co.; Rotating Equipment Division, E. B. Snyder, Bentley-Harris Manufacturing Co.; Insulating Materials Education Division, Jack Swiss, Westinghouse Electric Corp.

IRE Convention on Military Electronics June 26-28

On June 26-28 the professional group on Military Electronics of the Institute of Radio Engineers will sponsor its fifth Mil-E-Con (Conference on Military Electronics) in the Shoreham Hotel, Washington, D.C. Over 5,000 engineers, scientists, and electronics executives are expected to attend.

NEMA Code of Ethics, and Western Conference June 8-9

A committee has been appointed by the National Electrical Manufacturers Association to review the needs of the electrical manufacturing industry and to make recommendations for the proposed development of an industry code of ethics. Members of the committee are: N. J. MacDonald, The Thomas & Betts Co.; W. R. Persons, The Emerson Electric Manufacturing Co.; and E. R. Perry, National Vulcanized Fibre Co.

NEMA will hold its first conference west of Chicago on June 8-9 at the Biltmore Hotel, Los Angeles. Chris J. Witting, Westinghouse Electric Corp., will keynote the conference.

The conference is being directed by co-chairmen A. Arval Morris, Electra Motors Inc., and Raymond M. Waggoner, Hubbard and Co.

WESCON News

All eligible exhibitors have been granted space at the 1961 Western Electronics Show and Convention (WESCON) to be held in the Cow Palace, San Francisco, on August 22-25. Last year there was a waiting list of almost 200 applicants.

Special "credit cards" will be used by the anticipated 35,000 visitors to request product literature. The cards will be embossed with the name, title, company affiliation, and address of the visitor, who will simply present it to any booth representative. Exhibitor companies, all of whom will be supplied with imprinting machines by WESCON, will record all the name and address information on index cards, using them to mail the literature directly to the inquirer.

EIA Personnel Changes

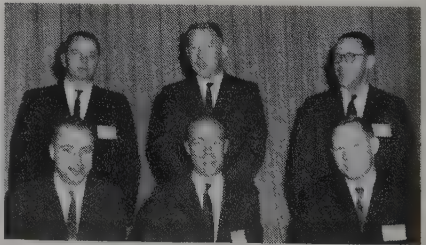
William H. Moore, former Department of Defense official, has joined the Electronic Industries Association staff as vice president of the Military Products Division. J. Frank Leach, Amphenol-Borg Electronics Corp., has been elected to the executive committee of the EIA Parts Division.

New Printed Circuit Officers

New officers of the Institute of Printed Circuits are R. L. Swiggett, Photocircuits Corp., president; R. G. Zens, Electralab Printed Electronics Corp., vice president; and R. C. Rennie, Bureau of Engraving Inc., treasurer.

Newly elected directors include: M. F. Mickelson, Fabri-Tek Circuits Inc.; and H. D. Petri, Ucinite Div., United Carr Fastener Corp.

Directors continuing on the board include: W. J. McGinley, Methode Manufacturing Corp.; J. R. Sibley, The Sibley Co.; G. J. Hart, Graphik Circuits Div., Cinch Manufacturing Corp.



Seated in photo (left to right) are Zens, Swiggett, and R. E. Pritchard, IPC secretary. Standing are McGinley, Mickelson, and Petri.

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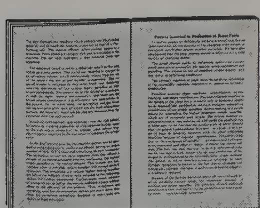

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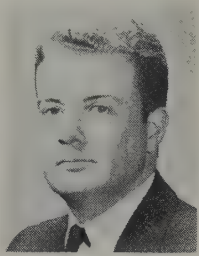
People in the News

Charles M. Ruprecht has joined the Hussmann Refrigerator Co., St. Louis, Mo., as vice president of manufacturing.

Recent elections at Taylor Fibre Co., Norristown, Pa., moved *Edward H. DaCosta* up to president and *John M. Taylor Jr.* to chairman of the board.



E. H. DaCosta *J. M. Taylor*

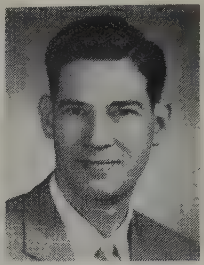
W. Roy Elliot has been elected president and general manager of Shawinigan Resins Corp., Springfield, Mass. He succeeds *Robert K. Mueller*, who was elected board chairman. New secretary and treasurer, respectively, are *William H. Bromley* and *Alfred W. Long*. Other appointments to vice presidencies include: *William H. Bromley*, marketing; *Dr. Robert N. Crozier*, research; *John C. Kenny*, production and engineering; and *Alfred W. Long*, finance and planning.

A. G. Heckman has been named executive vice president of Babcock Electronics Corp., Costa Mesa, Calif.

A. G. Heckman *M. Handelsman*

Dr. Morris Handelsman has been promoted to associate director of Advanced Military Systems, Defense Electronic Products, Radio Corp. of America, Camden, N. J. At Burlington, Mass., *Dr. George M. Nonnemaker* has been appointed Manager of Signal Processing Products for the Missile Electronics and Controls Div.

Joseph E. Trankla has been appointed general manager for the California Div. of Anadite Inc., South Gate, Calif.



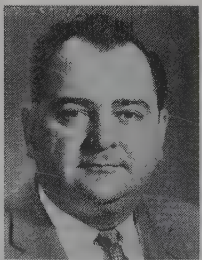
J. Trankla *W. Peters*

Flo-Tronics, Inc., Minneapolis, Minn., has appointed *William Peters* manager for its Air Conveying Div.

New technical sales representatives named by the Union Carbide Plastics Co., Div. of the Union Carbide Corp., include that of *John B. Honish* in the South Atlantic Sales Region (Greensboro, N.C.) and *Lawrence J. Kelly* in the Metropolitan New York Region (Clifton, N.J.).

At Hooker Chemical Corp., New York City, *Thomas E. Moffitt* has been elected chairman of the board and chief executive officer. He has been succeeded as president by *F. Leonard Bryant*, and *Thomas F. Willers* has been moved up to *Bryant's* former position as executive vice president.

Robert K. Sykora has been appointed to the newly created position of director of engineering for commercial laundry products at the Whirlpool Corp., Benton Harbor, Mich.



R. Sykora *W. Strout*

Oak Manufacturing Co., Crystal Lake, Ill., electrical components manufacturer, has elected *William S. Strout* vice president, purchasing.

General Electric Co. has named *Jack M. White* a salesman in the Insulating Materials Department's Chicago office, and appointed *Edward F. Coakley* to represent the Silicone Products Department in the New England District.

Robert W. Koma has been promoted to Philadelphia district manager for industrial sales, The Dobeckmun Co., Div. of the Dow Chemical Co. He is responsible for sales of industrial products in Eastern Pennsylvania, Southern New Jersey, Delaware, Virginia, and Washington, D. C.

Directors of Shallcross Mfg. Co., Selma, N. C., have elected *John E. Lillich* vice president in charge of manufacturing and *Clement W. Sharek* vice president in charge of engineering.

Jerry B. Finley has joined Saxonburg Ceramics Inc., Saxonburg, Pa., as a ceramic engineer.

W. Vernon Davey has been elected president and treasurer of The Dano Electric Co., Winsted, Conn., to succeed the late *Robert L. Noble*. *Harold D. Sisson* was elected vice president to succeed *Davey*.

Sheldon K. Towson Jr. has been elected president and chief executive officer of The Elwell-Parker Electric Co., Cleveland, Ohio, and *W. A. Meddick* has been moved up to chairman of the board.

S. Towson *W. Meddick*

Hale Dant has joined the Sales Department of JACO Products Co., Cleveland, Ohio.

John D. Gum has been appointed to the new post of director of engineer-

ing for the Photo-Optical Div., Consolidated Systems Corp. CS is an associate company of Allis-Chalmers, Bell & Howell, and Consolidated Electrodynamics.

The Norton Co., Worcester, Mass., has appointed George A. Garrison purchasing agent. The Refractories Division Sales Organization has announced the following changes: *Bruce Cramer* has been appointed to the newly formed Technical Development Department, Worcester, Mass.; *Jacob J. Walter* has been transferred from Philadelphia to succeed Cramer as refractories engineer in the Teterboro, N. J., area; *John A. Trogolo* goes from Chicago to succeed Walter in Philadelphia; and *Frederick W. Stover* succeeds Trogolo as refractories engineer in Chicago.

Leonard I. Kent has been elected vice president of engineering and member of the board of directors, Microwave Semiconductor & Instruments Inc., Queens, N. Y.


L. Kent *S. Chapman*

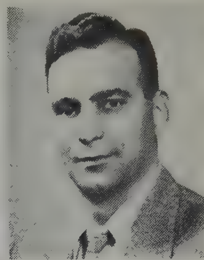
Stewart R. Chapman has been named assistant sales manager, aluminum products, for Rea Magnet Wire Co. Inc., subsidiary of Aluminum Co. of America, Fort Wayne, Ind.

G. F. Kolle has joined Inductotherm Linemelt Corp., subsidiary of Inductotherm Corp., Delanco, N. J., as assistant general manager and treasurer.

A. W. MacAlonan has been elected president of The Stalwart Rubber Co., Bedford, Ohio, to succeed the late *H. W. Osborn*. *Edwin H. Osborn* is the new executive president, and *Frank K. Byers Jr.* and *William P. Lindauer* are the new vice president and secretary, respectively. Other newly elected officers are *John J. Kravetz*, assistant vice president and director of research and development; *Richard R. Long*, assistant vice president and director—Silicone Division; and *Albert V. Volpe*, assistant vice president and director—production.

Cameron Corp., Ansonia, Conn., electronics manufacturer, has elected *Raul H. Frye* president.

James L. Winget has been appointed manager of the newly formed Inductosyn (transducers) Department, Del Electronics Corp., Mt. Vernon, N. Y.

J. Winget *D. Dunay*

Rogers Corp., Rogers, Conn., has named *T. H. Johnston Jr.* to the new post of director of manufacturing, and appointed *David R. Dunay* regional sales manager in the Northeast.

Moxness Products Inc., Racine, Wis., subsidiary of Plastics Corp. of America Inc., Minneapolis, has appointed *James E. Rogers* technical service manager.

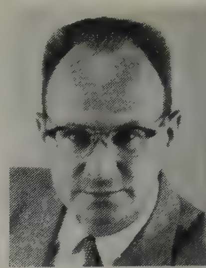
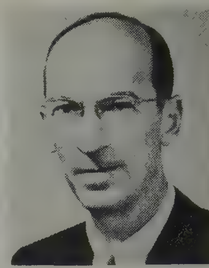
Charles M. Pritchett has joined The Mica Corp., Culver City, Calif., as a technical sales engineer in the Los Angeles and San Diego area.

New promotions in the General Chemical Div., Allied Chemical Corp., New York City, include that of *George C. Rayner* to assistant to the president, *Actor H. Patton* to director of product development, and *John R. Edmonds* to director of production.


A. H. Patton *J. R. Edmonds*

George H. Patton has been named plant manager of the technical ceramics plant being built in Laurens, S.C., by American Lava Corp., Chattanooga, a subsidiary of Minnesota Mining and Manufacturing Co., St. Paul, Minn.

New chief chemical engineer for Rotron Manufacturing Co. Inc., Woodstock, N.Y., is *Peter F. Grad*.

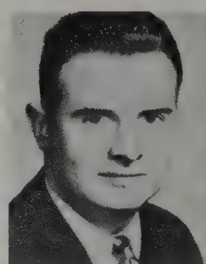
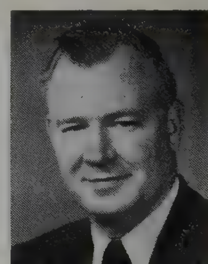



P. F. Grad *W. W. Garstang*

William W. Garstang has been appointed manager of special products, Centralab, The Electronics Div. of Globe-Union Inc.

James T. Ashley has been named to sell circuit board drilling machines made by Nawide Machine Tools Div., Nationwide Engineering Service Inc., Culver City, Calif.

Joseph Maher has been named a product sales manager of AMP Inc., Harrisburg, Pa., with responsibility for the firm's taper pin program, component tips, test probe receptacles, and fine wire applications.

J. Maher *W. Stuart*

Warren Stuart has been appointed sales manager of the Belden Manufacturing Co., Chicago.

New members of the research and development staff of Hysol Corp., Olean, N.Y., epoxy compounds manufacturer, are *William I. Childs* and *Jimmy W. Hill*.


W. I. Childs *J. W. Hill*

Polytechnic Institute of Brooklyn

has appointed *Dr. Nathan Marcuvitz* as vice president for research.

Richard L. Hopkins has been appointed to fill the newly created position of general manager, Accurate Specialties Co., Inc., Hackensack, N.J.

R. L. Hopkins

S. W. Gabriel

At General Cable Corp., New York City, *Sidney W. Gabriel* has been appointed director of purchases.

New promotions at Minnesota Mining and Manufacturing Co. include that of *R. C. Bertelsen* to manager of the tape plant in St. Paul, Minn., and *A. F. Jacobson* to manager of the tape and adhesives, coatings, and sealers plant in Bristol, Pa.

Marshall A. Williams has been named to the new position of executive director of marketing at Simplex Wire & Cable Co., Cambridge, Mass.

Sigmund J. Grinko has been named manager of manufacturing for the Tuttle & Kift Division of Ferro Corp., Chicago, to succeed *B. E. Beck*, who is now a vice president with the Precision Transformer Co., Elk Grove, Ill.

Hercules Powder Company, New York City, has appointed *William E. Davis* as its first senior research mathematician, and named *Charles P. Bertland* director of sales for the Fiber Development Department.

Zeke R. Smith has been named executive vice president and general manager of Potter & Brumfield, Division of American Machine & Foundry Co., Princeton, Ind. He succeeds *H. L. Huntsinger*, who has formed his own manufacturer's representative agency. *Huntsinger's* firm will represent the P&B relay line in the New York territory.

Eugene A. Christian Jr. has been named chief engineer, and *Albert H. Leader* has been appointed vice president of sales for the Sequoia Wire and Cable Co., subsidiary of Anaconda Wire and Cable Co., Redwood City, Calif.

W. E. Cantrell has joined the Electronics Division of Chance Vought Corp., Dallas, as a senior engineer in operations analysis.

Charles R. Wentz has been named manager of Reynolds Metals Company's new wire and cable plant in Chester, Pa.

Recent advancements at the Hollingsworth & Vose Co., East Walpole, Mass., include those of *Mark Hollingsworth* to executive vice president, *Grant Harrington* to vice president—sales, *Harold W. Knudson* to vice president—research, and *Albert L. Lincoln, Jr.* to sales manager. President *Aubrey K. Nicholson* has announced that he will retire October 15, 1961.

Appointments at the Shawinigan Resins Corp., Springfield, Mass., include: *Edward Lavin* to director of applications research; *Dr. Aubrey F. Price* to director of product research; and *Harold D. Weymouth* to director of research administration and planning. New section leaders in research are: *Dr. Albert H. Markhart, Leo J. Monaghan, Dr. Ralph F. Nickerson, Dr. Forrest H. Norris,* and *Herbert Terry.*

Frederick R. Lack has been named to the newly created post of senior vice president in charge of research of the Sprague Electric Co., North Adams, Mass. At the same time, *Neal W. Welch* and *Dr. Wilbur A. Lazier* were added to the board of directors.

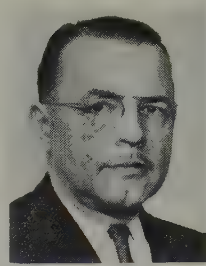
Newly elected vice president and director of Reeves Soundcraft Corp., Danbury, Conn., is *Arthur J. Seiler.*

At Designers for Industry, Inc., Cleveland, Ohio, *Ervin J. Osterhus* has been promoted to executive vice president and *Walter J. Hood* has moved up to vice president of engineering.

E. J. Osterhus

W. J. Hood

Richard T. Kropf has been elected president and chief administrative officer of Belding Hemingway Co., Inc., New York City.



R. T. Kropf

J. Kolozs

John E. P. Kolozs has been appointed vice president of marketing for electrical components and equipment for Electrovert Inc.

At the Chance Vought Corp., Dallas, Texas, *F. O. Detweiler* has been named chairman of the board, *Gifford K. Johnson* has been appointed president and chief executive officer, and *J. R. Clark* has been promoted to vice president and general manager of the Astronautics Division.

Several personnel changes have been announced by Wabash Magnetics Inc., Wabash, Ind. *R. O. Jefferson* is general manager of both the Deluxe Coils Division and the Hi-Voltage Division, and *William Scholten* is general manager of the Miniature Products Division. The Central Engineering Division continues under Wabash chief engineer *Lewis Dumbauld*. Plant managers are *Ray Dillman, Leonard Trinkle,* and *Lowell McLaughlin.*

R. Jefferson

W. Scholten

Pennsalt Chemicals Corp. has appointed *Linwood T. Geiger* as manager of its Delware, Ohio, plant.

Alfred H. Macgillivray has been appointed works manager of the Rockbestos Wire & Cable Co., New Haven, Conn., a division of Cerro Corp.

William T. Day and *Joseph T. Thayer Jr.* of The Day Engineering Co., King of Prussia, Pa., have been appointed sales representatives in the

Philadelphia-Baltimore area by the Leon J. Barrett Co., Worcester, Mass.

Elwood C. Eldridge has been appointed a sales engineer by Pennsylvania Fluorocarbon Co. Inc., Philadelphia, Pa.

Ora F. Kuhlman has been appointed director of engineering for Key Resistor Corp., Gardena, Calif.

O. Kuhlman

M. E. Latham

M. Elber Latham has been named manager of the Youngstown, Ohio Division of Swedlow Inc., which makes thin epoxy/glass laminates.

Jesse L. Hubbard has been appointed chief engineer of Southern Electric Inc., Hammond, Ind.

Sales representative assignments by Johns-Manville Sales Corp. include that of *August Beucke,* Cleveland, Ohio; *Robert D. Wisbon,* Philadelphia, Pa.; and *Thomas D. Hoffstatter,* Tulsa, Oklahoma.

Technical sales representatives named by Union Carbide Plastics Co., Division of Union Carbide Corp., include *George H. Dougherty Jr.,* Midwest (Chicago); *Thomas T. Spooner,* South Atlantic Region (Moorestown, N.J.); and *W. Warren Swenson,* Metropolitan New York (Clifton, N.J.).

Newly elected vice presidents of the John C. Dolph Co., Monmouth Junction, N.J., are *Walter E. Harvey,* in charge of plant and laboratory, and *John D. Mayes,* sales.

Dr. Robert A. Bernoff has been appointed director of research for Materials Electronic Products Corp., Trenton, N.J.

Roy M. Casper has been appointed general manager, Power Equipment Division, Allis-Chalmers Manufacturing Co., to succeed *J. W. McMullen,* who is retiring. He is succeeded as general manager of the Atomic Energy Division by *Harold Etherington.*

Archie F. Boscia has been named chief engineer of Resdel Engineering Corp., Pasadena, Calif., VHF and UHF aerospace instrumentation manufacturer.

Forrest H. Judkins has been appointed manager of manufacturing for the Insulator Department, General Electric Co., Baltimore, Md. At Schenectady, N.Y., *Peter C. Van Dyck* has been named general manager of GE's Service Shops Department. He replaces *J. J. Durkin* who has retired.

Arthur J. Sherburne, who recently retired after 40 years with the Insulating Materials Department of General Electric Co., has accepted the position of director, Materials Laboratory, Engineering Research Division, the Louis Allis Co., Greendale, Wis.

A. Sherburne

C. Gardner

C. L. Gardner has been named sales manager for Schenectady Varnish Canada Limited, Toronto, Ontario, Canada.

At the J. P. Devine Manufacturing Co., Pittsburgh, Pa., *G. Robert Cox* has been promoted from vice president to president. He succeeds *A. M. Cox* who has been named chairman of the board.

J. Alfred Earl has been appointed director of research for Physical Sciences Corp., Pasadena, Calif., affiliate of Packard-Bell Electronics.

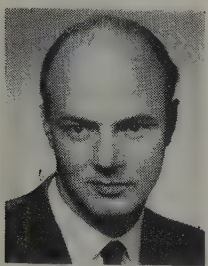
At the Corning Glass Works, Corning, N.Y., *Amory Houghton* has been elected chairman of the executive committee. *William C. Decker* succeeds him as chairman of the board of directors and chief executive officer, and *Amory Houghton Jr.* replaces Decker as president.

New manager of materials for Continental-Diamond Fibre Corp. in the Newark, Del., plant, is *John E. Bozzuto.*

L. F. Hickernell, vice president of engineering for the Anaconda Wire

and Cable Co., Hastings-on-Hudson, N.Y., has been elected to a four-year term on the Engineering Foundation Board by the United Engineering Trustees, Inc.

Kenneth M. Miller, formerly vice president of Motorola Aviation Electronics, has been named vice president and general manager of Daystrom-Pacific, Los Angeles, a division of Daystrom, Inc.


K. Miller


J. Schnelle

Jack D. Schnelle has joined The Kendall Company's Fiber Products Division as midwest sales representative with headquarters in Cleveland.

The Shelton Division, United Shoe Machinery Corp., Shelton, Conn., has appointed *W. Gordon Taylor* to product manager of eyelets for use in the electrical/electronic and other industries.

Dr. Ray L. Hauser has recently founded the Hauser Research and Engineering Co., Littleton, Colorado, to provide consulting and research services related to non-metallic materials. The firm will specialize in plastics for cryogenic temperatures.

Alfred F. Van Ranst has been elected vice president of Inca Manufacturing Division, Phelps Dodge Copper Products Corp., Fort Wayne, Ind.

American Pres-Stix Tape Co. has appointed *Donald B. Roberts* to head the St. Louis sales office and *Martin Progebin* to direct the eastern branch.

Associated Testing Laboratories Inc. has named *Joseph F. Beattie* chief engineer of its New England Division Laboratory in Burlington, Mass. *Don Jensen* will be assistant chief engineer.

Louis J. Matson Jr. has been appointed assistant sales manager for the Fluid Systems, Wire and Cable and Harness Divisions of Revere Corporation of America, Wallingford, Conn. (*Continued on page* 68)

Albert H. Miller has been elected president of the John A. Manning Paper Co. Inc., Troy, N.Y.

A. Miller

L. Feldman

Victory Wire and Cable Corp., Los Angeles, has elected *Leon Feldman* president.

Robert E. Johnson has joined the Shallcross Manufacturing Co., Selma, N.C., as vice president and sales manager.

Hugh B. Allison and *Joseph S. Hawes* have been elected to the board of directors of Chemical Products Corp., Providence, R.I.

Loral Electronics Corp., New York, N.Y., has appointed *Milton Brenner* to the newly created post of assistant chief engineer, Development.

Robert D. Cutkosky, a physicist in the Resistance and Reactance Section of the National Bureau of Standards, has been awarded the U. S. Department of Commerce Silver Medal for Meritorious Service for "very valuable contributions in the field of electrical measurements and standardization."

Frank M. Lefor has joined Narda Microwave Corp., Mineola, N.Y., as product engineer.

Kenneth B. Smith has been appointed Manager of the Fabrication Department at Spaulding Fibre Co. Inc., Tonawanda, N.Y. Other Spaulding appointments include that of *Vincent N. Nobile* to manager of the Detroit sales branch, *William E. Gilbert* to director of application engineering in Tonawanda, *Eugene G. Monnig Jr.* to manager of a new sales branch in St. Louis Park, Minn., and *W. Owen Graham, Jr.* to manager of the new sales branch in Dallas, Texas.

Walter L. Erley has been promoted to Midwestern regional sales manager (Chicago) by Rogers Corp., Rogers, Conn.

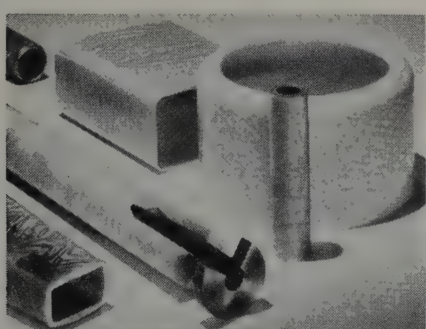
Alexander J. Simpson has joined Saxonburg Ceramics Inc., Saxonburg, Pa., as ceramic engineer.

New Materials and Components

For further information on these products print the item number on the Reader Service Inquiry Card on the back cover. Fill out and mail the card—no postage is required. Insulation *will immediately forward your inquiry to the manufacturers concerned so that they can send you more information promptly.*

Silicone Rubber for Wire and Cable

A new silicone rubber compound (SE-9007) for use as wire and cable insulation is designed primarily for high quality aircraft, hook-up, motor lead, and similar wire applications. It reportedly offers excellent processing characteristics, easy milling, high extrusion speeds, and very good diameter control. Typical physical properties as extruded on wire are: tensile strength of 1200 psi and elongation of 425%. Electrical properties reported at 77°F and 50% RH on 6″ x 6″ x .040″ sheets oven cured 24 hrs/480°F before and after 29 days immersion in water at 158°F are: volume resistivity (ohm-cm), 5 x 10^{15} and 5 x 10^{15}; electric strength (vpm), 650 and 650; dielectric constant (60 cps), 3.0 and 3.2; and power factor (60 cps), .001 and .001. SE-9007 is priced at $3.25/lb in 1000 lb quantities. Silicone Products Dept., General Electric Co., Waterford, N.Y.



Print No. Ins. 101 on Reader Service Card

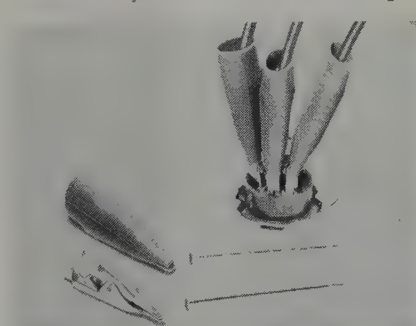
Glass Filament Wound-Epoxy Tubing

GFW-60, a new glass filament wound-epoxy tubing, is said to have burst strength properties which exceed those of the familiar G-10 grades by about 3 to 1. Manufactured of continuous strands of glass filaments that are bathed in epoxy resin, helically wound, and then heat cured, GFW-60 reportedly makes it possible to achieve exact ratios between burst and tensile strengths to meet the requirements of specific applications. Applications in high-voltage fuse tubes, switchgear, and other components requiring high burst strength are foreseen. Tubing is available in a variety of circular sizes and lengths or in special cross-section shapes, such as rectangular. It can also be furnished in combinations with vulcanized fibre tubes or metal inserts. Spaulding Fibre Co. Inc., 310 Wheeler St., Tonawanda, N.Y.

Print No. Ins. 102 on Reader Service Card

Vinyl-Insulated Electric Clip With Tiny Tip

The miniscule tip of a new "Microgator" clip has been tailored to fit tiny electrical and electronic components. Insulator and all, the tip of the inch-long clip is no larger than a pin head, allowing its use on the smallest, tightest-packed terminals and on printed circuits. The clip is supplied in both cadmium-plated steel and in solid copper. The skin-tight, thin-walled flexible vinyl insulators are sold separately in colors for multiple-lead identification. The insulators cover the entire clip but are provided with "lip-action" tip slots which keep the jaw tips covered whether closed or opened. Samples available. Mueller Electric Co., 1575G East 31st St., Cleveland 14, Ohio.

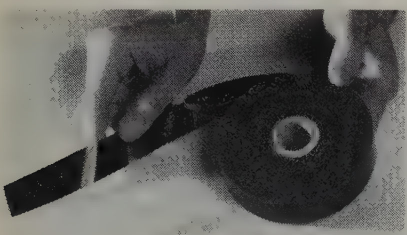


Print No. Ins. 103 on Reader Service Card

Varnished Polyester/Glass Fabric and Tape for Class B Motor Insulation

A new high-dielectric strength in-

sulating fabric and tape is said to have better flexibility, superior elongation properties, and greater resistance to edge tear than conventional varnished cambric material. It conforms to irregular surfaces without need for bias weave construction and has improved heat-aging characteristics, good slip for tight wrap, and high tensile strength. It will be marketed at price levels prevailing for varnished cambric material for such suggested uses as coil wrapper, phase, ground barrier, slot, and layer insulation. Physically and chemically, the new 5J30 material is a black, flexible, varnish-treated, class B material composed of "Dacron" polyester fibers and glass fibers. The following characteristics for 0.008″ thick material are stated

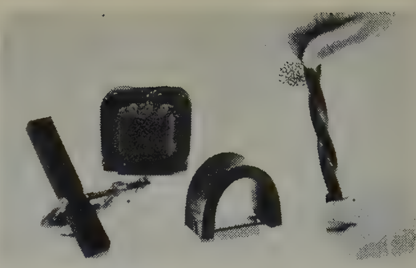


to be typical: Tensile strength along major dimension is 43 lbs/in width, across major dimension it is 109 lbs/in width; edge tear strength is 80 lbs/in width; and dielectric strength is 2000 vpm with ¼″ electrodes. Micarta Div., Westinghouse Electric Corp., Trafford, Pa.

Print No. Ins. 104 on Reader Service Card

Flexible Epoxy Resin System for 155°C Use

A new one-part, low-viscosity, class F (155°C) epoxy resin system is said to combine a new degree of flexibility with high temperature physical and electrical stability. It is claimed to exert little, if any, pressure on embedded parts during cure, enabling it to be used as a void-free impregnant or encapsulant of components with sensitive core materials or extremely fine wire. Designated as "Scotchcast" brand electrical resin No. XR-5029, the system reportedly is non-corrosive, has an impregnating viscosity similar to light machine oil (150 cps) at 150°C, has good wetting properties,



is the most flexible epoxy system available today, and remains electrically and physically stable under continuous use in the 155°C range. Shore D hardness is 18. XR-5029 will adhere to most metals and plastics and will resist most chemicals. The resin is currently being used in a military transformer meeting MIL-T-27A specifications at a continuous operating temperature of 170°C. Other characteristics reported include stability at room temperature, long pot life (7 days at 65°C and 4 days at 95°C), and a medium cure cycle (8 to 16 hrs at 150°C). An extended post-cure cycle at 150°C further extends the electrical and high temperature properties. Dept. W1-161, Minnesota Mining and Manufacturing Co.,

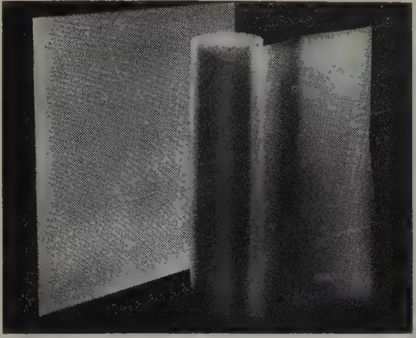
900 Bush Ave., St. Paul 6, Minn.
Print No. Ins. 105 on Reader Service Card

Insulating Coating for Electrical/Electronic Components

A new, one-component coating is said to be especially suitable for use on capacitors, resistors, transistors, diodes, coils, armatures, motor windings, and many other electronic components. This transparent coating, Humi-Seal type 1F19, dries at room temperature, becoming tack-free within 30 minutes, and is then oven-cured. Type 1F19 is stated to be suitable for operating temperatures up to 350°F and down to —90°F (177°C to —67.8°C). Excellent resistance to moisture, chemicals, corrosive gases, fungus, weathering, salt spray, and aging; excellent adhesion, abrasion resistance, and flexibility; and excellent insulating properties are claimed. It will withstand the heat generated by soldering and has a shelf life of six months at room temperature. Data available. Columbia Technical Corp., 24-30 Brooklyn-Queens Expressway, West, Woodside 77, N.Y.
Print No. Ins. 106 on Reader Service Card

Thin Epoxy-Glass-'Mylar' Laminates Qualified to MIL-P-18177B

A thin, glass cloth-epoxy laminate with "Mylar" faces qualified to MIL-P-18177B is available in continuous sheets, strips, and coils of any length in thicknesses of .015, .022, .032, and .062. The laminate (Code X6G-280) is said to exceed NEMA G-10 and FR-4 requirements and to meet AIEE class F specifications. Excellent dielectrics, high strength/weight ratio, and excellent chemical and moisture resistance are reported. Bond strength exceeds 750 psi (ASTM D-952). A second continuous, glass cloth reinforced laminate with Mylar faces (Code X6G-278) is also said to exceed NEMA G-10 and to meet requirements of AIEE class F and NEMA FR-4. It is available in thicknesses of .007, .010, .020, .032 and .062. Bulletin EGL-100 available. Swedlow Inc., Box 2324, Youngstown 9, Ohio.
Print No. Ins. 107 on Reader Service Card



Sheeting Grade Polypropylenes

"Escon" 502 and 522, two new polypropylene grades for sheet extrusion, reportedly have a melt index of 0.6 and are adaptable to vacuum forming operations. Escon 502 is a general-purpose sheeting grade priced at 42¢ per lb. The two new grades are expected to find use in applications where pieces with large surface areas must be fabricated. They are said to offer outstanding resistance to chemicals and to stress cracking. Enjay Chemical Co., Room 1122, 15 West 51st St., New York 19.
Print No. Ins. 108 on Reader Service Card

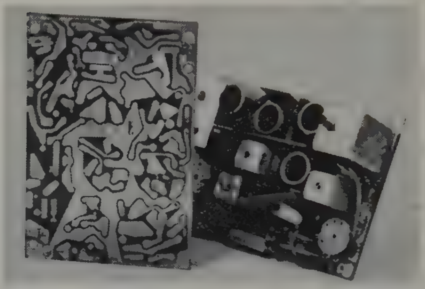
'Teflon' FEP Resin Dispersion and Spray for Coating and Impregnating

New "Teflon" FEP fluorocarbon resin dispersion, coded Teflon TE-9500 FEP, is expected to find wide acceptance as a class H impregnant and surface coating for wire and cable, component insulation, and in electrical and chemical applications. TE-9500 reportedly provides low permeability coatings, excellent heat sealability, high dielectric strength in thin films, and may be fused at lower temperatures than dispersions of the older TFE resins. In addition, TE-9500 is said to offer better electrical properties, chemical resistance, and lower weight loss at service temperatures than other high temperature impregnants. Surface coatings of the FEP dispersion, or impregnated fabrics or yarns containing it, can be sealed together, or to wire insulation, films, or massive shapes made from FEP or TFE fluorocarbon resins. TE-9500 is a water-based dispersion containing 6½ lbs of finely divided FEP fluorocarbon resin solids per gallon. Teflon FEP fluorocarbon resin spray finishes are stated to offer improved corrosion protection in surface coatings. These finishes are coded 851-454 enamel green and 852-401 clear. It is claimed that adherent, low permeability coatings of the FEP finishes may be fused at temperatures of 575 to 625°F (301.5 to 329.5°C). E. I. du Pont de Nemours & Co. Inc., Wilmington 99, Del.

Print No. Ins. 109 on Reader Service Card

Fire-Retardant Copper Clad Phenolic Laminates for Printed Circuits

Two new fire-retardant, cold punch, copper-clad, paper-base/phenolic laminates of XXXPC grade—65M05 and 65M06—are expected to be used principally in radio and television printed circuits. Grade 65M05 is recommended for small circuits or miniaturization. High bond strength and solder resistance are claimed. The 65M06 laminate is said to be particularly advantageous in automatic fabrication processes that require close registration of holes and circuits. Outstanding characteristics reported for



it are freedom from warp, high impact strength, high adhesion, high insulation resistance (retained in humid conditions), and low moisture absorption. Both laminates pass the Underwriters' Laboratories' five-second flame-out test. Printed circuits can be dip-soldered without blistering or distortion. Blister time at 500°F is reported as 25 seconds. Micarta Div., Westinghouse Electric Corp., Hampton, S.C.

Print No. Ins. 110 on Reader Service Card

Longer Epoxy Rods

Epoxy is now produced in rod form 72" long to meet all MIL Spec performances. Four standard types of formulations are available in stock, No. 31 (260°F, HDT); No. 32 (310°F, HDT); No. 33 (345°F, HDT); and No. 34 (410°F, HDT). All diameters reportedly are within ±0.001 tolerance over the entire 72" length. Brochure available. Rad Elec-

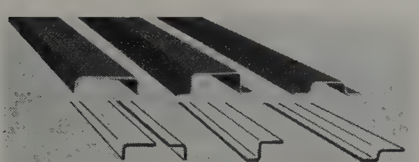
tronic Plastics Inc., 1466 Herkimer St., Brooklyn 33, N.Y.
Print No. Ins. 111 on Reader Service Card

Low Temperature Silicone Rubber

A new extremely low temperature resistant silicone rubber compound is designed for use in molded and extruded seals and gaskets and other applications. Designated SE-5401U, the new material is a gray, 40 durometer compound which may be used to meet specifications MIL-R-5847D, Class I, Grade 40 and AMS-3334. SE-5401U is said to be an easy processing compound with the following typical properties after 24 hrs/480°F: hardness, shore A, 40; tensile strength, 900; elongation, 400%; tear strength, Die B, pi, 65. Price is $4.25/lb in 1000 lb quantities. General Electric Co., Silicone Products Dept., Waterford, N.Y.
Print No. Ins. 112 on Reader Service Card

Fiber Glass Reinforced Polyester Insulating Channels in New Sizes

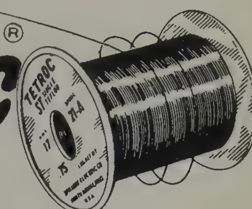
Three new sizes of channel stock have been added to a line of structural insulating shapes which reportedly serve as low cost, product improving replacements for stand-off insulators, wood members, and insulated metallic members. The high strength fiber glass reinforced polyester shapes

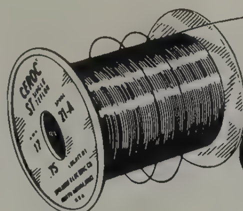


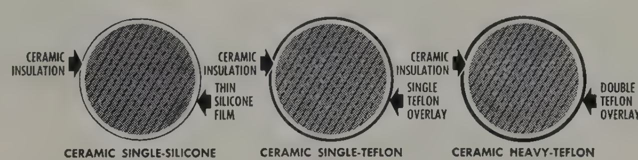
can be used as is or cut into angles or other forms to meet specific job requirements. Applications include component bases, insulating offsets, bus supports, enclosures, cable supports, transformer corners, fuse mountings, wire raceways, stiffening bars, etc. The stock is engineered for use in equipment operating at class B temperatures (130°C). It meets NEMA GPO-1 specifications and has UL-recognized flame retardance. Engineering data and prices available. The Glastic Corp., 4321 Glenridge Rd., Cleveland 21, Ohio.
Print No. Ins. 113 on Reader Service Card

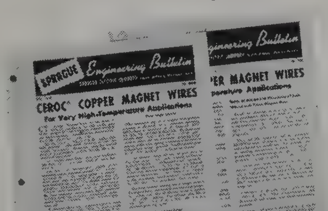
Silicone-Epoxy Compounds for Potting, Encapsulation, Caulking

Epoxy, silicone rubber, and combi-







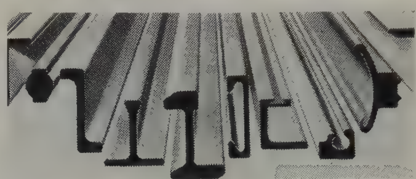


nation materials have been developed for potting, impregnating, caulking, and molding in a variety of applications. Materials currently available are: *Eccosil 4850,* a general purpose RTV silicone rubber compound with a temperature capability up to 600°F (316°C) used for potting, caulking, and mold making. *Eccosil 4640,* a low-weight RTV silicone rubber for use up to 600°F in airborne applications. Weight is under 40 lbs/cu ft (Sp Gr, 0.6). *Eccosil 4712,* a general purpose epoxy-silicone with 450°F (232°C) temperature capability for potting applications. Retains flexibility after heat aging. *Eccosil 4520,* a low viscosity epoxy-silicone impregnant and potting compound with 450°F temperature capability for impregnating and dip-coating transformers, coils, etc. Significant properties of the new materials are said to include electrical excellence, particularly at elevated temperatures. The epoxy-silicone materials reportedly possess excellent adhesion, handling ease, and rugged physical properties. One compound, Eccosil 4712, is claimed to be particularly useful in cable connector potting. The epoxy materials are also said to be flexible and to retain flexibility after heat aging for prolonged periods at 450°F. Emerson & Cuming Inc., Canton, Mass.

Print No. Ins. 114 on Reader Service Card

Fiber Glass Extruded Shapes For Class B, F, and H Uses

Fiber glass extruded shapes for class B, F, and H electrical insulation applications are produced in a new continuous extrusion process. The ex-



truded profiles, with unidirectional or omnidirectional reinforcing fibers, can be manufactured to customers' drawings and specifications. Intricate shapes in sizes ranging from 1/64″ to approximately 6″ diameter and lengths limited only by shipping restrictions can be extruded. New Plastic Corp., 1026 N. Sycamore Ave., Los Angeles 38.

Print No. Ins. 115 on Reader Service Card

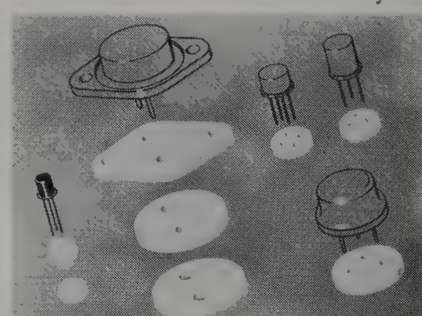
Liquid Epoxy Novolac for High Temperature Uses

New liquid epoxy novolac resin for ultra high temperature potting, casting, dipping, and coating compounds is said to be stable from —60°C through +280°C. The low viscosity resin, tradenamed "Isochemrez" 460, takes 20% more catalyst than normal epoxy resin. Isochem Resins Co., 221 Oak St., Providence, R.I.

Print No. Ins. 116 on Reader Service Card

Transistor Dielectric Heat Sinks

A simple aid to increased reliability and efficiency of transistorized military and industrial devices is offered by transistor dielectric heat sinks. Used to insulate semiconductor devices from the chassis, these heat sinks utilize beryllium oxide's ability to resist the flow of electricity but not the flow of heat, allowing high power without exceeding temperature limits. Thermal conductivity equalling that of aluminum metal is said to permit these heat sinks to maintain semiconductor temperatures at least 50% lower for a given power level than those allowed by dielectric materials now used for semiconductor mounting. Barlox heat sinks also are said to have extremely low capacitance, and thus will minimize problems in high-frequency circuitry which occur with conventional dielectric materials. In addition to electrical resistivity ex-

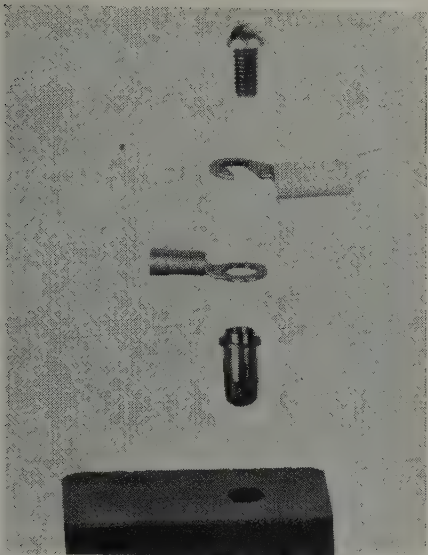


ceeding 10^{15} ohm-cm, properties reported include extremely low dielectric loss (< .0008) over the entire frequency range at which semiconductors are applied, resistance to moisture, free of outgassing, infinite shelf life, and high resistance to shock and vibration. National Beryllia Corp., First & Haskell Ave., Haskell, N.J.

Print No. Ins. 117 on Reader Service Card

Threaded Insert Makes Electrical Connection in Molded Plastic

The Dodge line of expansion inserts —designed to provide durable brass threads in molded plastic—now includes inserts which provide electrical connections. The "Clinch Insert" is

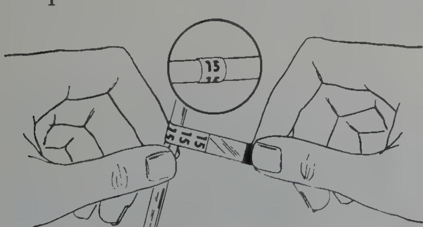


said to be especially suited for such molded plastic parts as terminal blocks, switch components, and related electrical parts. An eyelet, which protrudes above the surface of the workpiece, is the new insert's primary feature. By placing a terminal or contact strip over the eyelet and then crimping the eyelet over the terminal, a strong and highly conductive electrical connection is formed. Lead wires may then be attached to the connection by a conventional binding screw threaded into the insert. Bulletin P-102 available. Phelps Mfg. Div., Heli-Coil Corp., Danbury, Conn.

Print No. Ins. 118 on Reader Service Card

Wire Marker Protects Itself

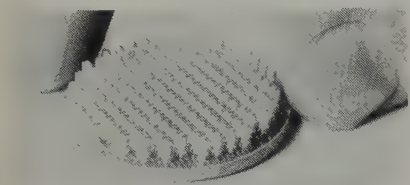
New E-Z-Code self-laminating wire markers reportedly offer exceptional resistance to all conventional oils, greases, chemicals, fluids, and other foreign matter. Each self-adhering, self-laminating marker is partly a precoded marker and partly transparent with a self-contained lamination extension. The protective clear portion wraps around the coded area. Mate-



rial is said to be a tough vinyl plastic that sticks tenaciously. Brochure and samples available. Westline Products Div., Western Lithograph Co., 688 East 2nd St., Los Angeles 54, Calif.
Print No. Ins. 119 on Reader Service Card

Miniature Terminal Boards

Miniature terminal boards on .100 grid patterns in any shape are now available with glass-filled epoxy, melamine, or silicone insulation. Board shape can be formed to fit customer's equipment. Printed circuitry as an integral part of the board can be supplied. Pictured is a typical part containing 100 terminals per sq in. Bulletin MB-3 available. Accurate Electronics Corp., 169 South Abbe Road, Elyria, Ohio.



Print No. Ins. 120 on Reader Service Card

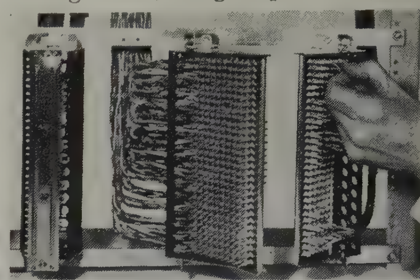
Shielded Marine Cable for Seismic And Underwater Sound Applications

New "Remaco" type C-11 cable is a flexible 5-conductor cable with a neoprene jacket. Good durability, nonhygroscopic construction, and high tensile strength are said to suit it for wide application in seismic and underwater sound instrumentation. Remaco type C-11 cable has an OD of 0.525″ (±0.025″). It contains five stranded No. 18 Awg, copperweld conductors with a resistance per conductor of approximately 17.5 ohms per 1000 ft at 25°C. The conductors are cabled with rubber fillers and "Mylar" tape, shielded overall with tinned copper braid. Tensile strength

of the cable is 600 lbs. The shipping weight is nominally 205 lbs/1000 ft. Continuous lengths are available to 5000 ft. Research Mfg. Corp., P.O. Box 6056, San Diego 6, Calif.
Print No. Ins. 121 on Reader Service Card

Solderless Wire Terminating Device

A new solderless wire terminating device designed to be used as a multipin connector, or as a terminal block, or both at the same time, is trademarked "Connecto-Blok." The Connecto-Blok is said to combine the foremost advantages of both a connector and a terminal block, while it eliminates the prime disadvantages of high wiring costs, large space require-



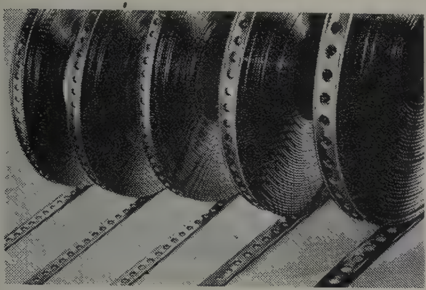
ments, and cumbersome installation conditions. Electrical connection between two wires is made by crimping a female tab terminal on each end of the wires, and in turn plugging the terminals on opposite ends of a male pin located on the connector block. The terminal blocks now available house up to 300 male pins and are similar in appearance to tree-type

solder terminal blocks. The Thomas & Betts Co. Inc., 36 Butler St., Elizabeth, N.J.

Print No. Ins. 122 on Reader Service Card

New Nylon Strapping Sizes

Several new sizes have been added to a line of perforated nylon strapping. The complete line now includes strapping widths from .160″ to ⅝″, thicknesses from .030″ to .070″, in

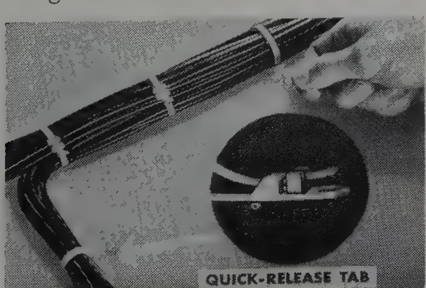


various hole sizes and spacings or non-perforated. The strapping is available in either black or natural nylon from stock in 25- or 50-ft roll dispensing packages. Strapping is made of tough, durable non-conducting nylon said to be suitable for service between —60°F and 275°F (—51.1°C to 135°C). Highly solvent-resistant, the units reportedly are unaffected by petroleum oils and greases at temperatures up to 300°F. Weckesser Co. Inc., Dept. IN-2, 5701 Northwest Hwy., Chicago 46.

Print No. Ins. 123 on Reader Service Card

Flexible Cable Clamps and Ties

"Lok-Strap" adjustable cable clamps and cable ties are now available in a new material providing flexibility from —65°F to +225°F (—53.9°C to +107°C). They are stated to be unaffected by moisture and to be extremely durable—even in applications subject to extreme flexure and vibration—do not become brittle due to low temperature exposure, nor do they show any appreciable "stretch" at their upper rated service temperature. None of the original cost-saving design features have been sacrificed.

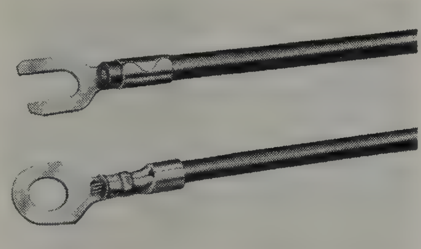


Lok-Straps can be opened, closed, and re-adjusted repeatedly without damage, without special tools. The miniature quick-release tab holds the band of the clamp or tie around wires—but opens when pressure is applied. The tab also allows adjustments to accommodate wire harnesses from ⅛″ to 2″ in diameter. Excellent electrical insulating characteristics and high tensile strength are also claimed. Panduit Corp., Dept. IN-2, 17301 Ridgeland Ave., Tinley Park, Ill.

Print No. Ins. 124 on Reader Service Card

Spade and Ring Terminals

Spade and ring terminals designed to accommodate a wide range of wire and insulation sizes are now available in chain form for high speed production. Brass or tinned brass terminals are available in three crimps: with insulation support, without insulation

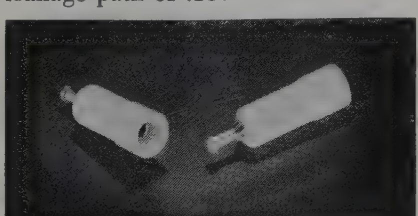


support, or with an insulation pierce crimp. Insulation ranges are from .035″ to .110″ and wire ranges are from 20 to 27. A machine designed for rapid semiautomatic crimping of all spade and ring terminals in production line setups is also available. Malco Manufacturing Co., Dept. IN-2, 4025 West Lake St., Chicago 24.

Print No. Ins. 125 on Reader Service Card

Test Jack Features Long Leakage Path for HV

For installations requiring high voltage ratings, the Press-Fit type SKT-27 test-point jack provides a leakage path of .187″ or more and is



rated at 2000 vrms at sea level. The SKT-27 accepts a test probe .450″ long by 0.93″ in diameter. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N.Y.

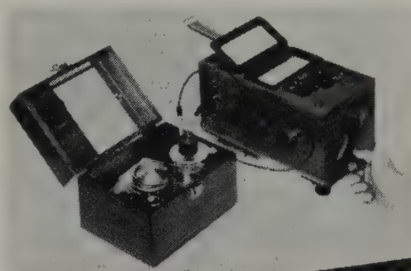
Print No. Ins. 126 on Reader Service Card

New Instruments and Equipment

For further information on these products print the item number on the Reader Service Inquiry Card on the back cover. Fill out and mail the card—no postage is required. Insulation *will immediately forward your inquiry to the manufacturers concerned so that they can send you more information promptly.*

Test Cell Kit for Liquids

Kit is designed for use with a Megger insulation tester in making measurements of the resistivity of liquids, such as transil oil and insulating varnishes. The Biddle-Balsbaugh Cell is packaged as a kit with a jar for

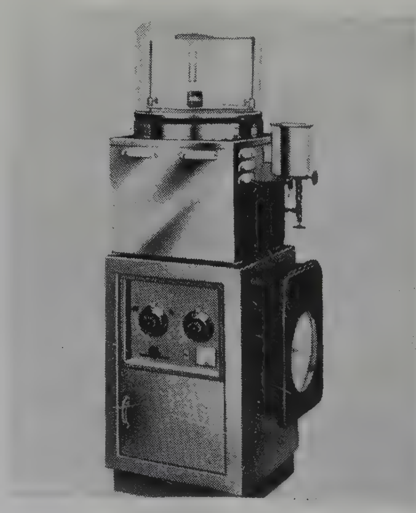


storing the cell free from contamination while not in use. An aluminum beaker and a quantity of polyethylene-coated paper cups are provided. The three test leads are insulated for test voltages of up to 5000 v d-c. The complete kit is contained in a sturdy and serviceable case with handle. Bulletin 21-OC-93 available. James G. Biddle Co., 1316 Arch St., Philadelphia 7.

Print No. Ins. 201 on Reader Service Card

Relative Humidity Chamber

New Model VP-206A controlled

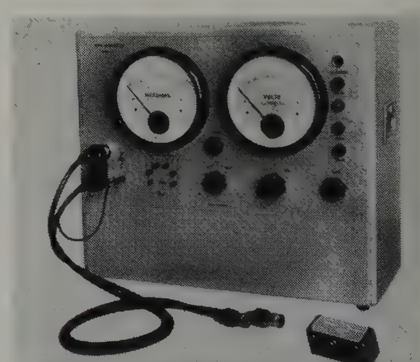


relative humidity chamber is designed to meet the requirements of MIL-202B, method 106A, steps 1-6. Chamber capacity is also suitable for performing method 103A, procedure 2. Outstanding features are said to include an automatic cycle between 25°C and 65°C, humidity held to ±1% throughout cycle, minimum maintenance, and straight-line performance for both wet and dry bulb controls. Bulletin 7005C available. Blue M Electric Co., 138th and Chatham St., Blue Island, Ill.

Print No. Ins. 202 on Reader Service Card

Insulation Measurements Instrument

The teraohmmeter is said to have many unusual features which make it invaluable for insulation measurements. Designed for accurate resistance measurements, the Jahre teraohmmeters cover the range 2 megohms to 5000 teraohms (5×10^{15} ohms) at potentials up to 1000 v. The instrument uses a single tube to provide stability The teraohmmeter is



direct reading, with a guaranteed accuracy of 3% over the center ⅓ of its logarithmic-type scale. Two 7" meters, of 0.5% accuracy, are used for voltage and resistance indications. The teraohmmeter automatically sums the capacitive, electron, ion, and surface components of current through the material under test. From this current and the tube parameters, the resistance scale is calibrated. Leakage is eliminated by guard-ring technique, and the instrument is protected against damage should the insulation under test break down or be inadvertently short-circuited. The same technique also insures that the insu-

lation of the cables used does not affect the measurements of the material tested. With optional liquid sample holders, the teraohmmeters may be used for testing of transformer oils, for example, both for breakdown and for purity. The teraohmmeter is also recommended for such applications as moisture content of insulating materials, surface condition and temperature coefficient determinations, determination of voltage coefficients of materials, and determination of leakage resistance of capacitors. Literature available. Rohde & Schwarz Sales Co., Inc., 111 Lexington Ave., Passaic, N.J.

Print No. Ins. 203 on Reader Service Card

Electronic Voltmeter

An electronic voltmeter with its voltage scale calibrated in rms voltage of a pure sine wave is designed for measurements of a-c voltages from audio frequency level to RF level as well as hum and noise voltage levels. Model V-100 voltmeter reportedly provides easy-to-read measurements from .001 to 300 a-c volts over a frequency range of from 10 cps to 4 mcs. A direct reading of from —72 db to +52 db in 12 ranges provides convenient measurements of DBM. Model V-100 measures 7¼"W × 11¼"H × 13¾"L. Weight is 18 lbs. Price is $198. Orion Electronic Corp., 108 Columbus Ave., Tuckahoe, N.Y.

Print No. Ins. 204 on Reader Service Card

Vibration Generators
Test Parts, Assemblies

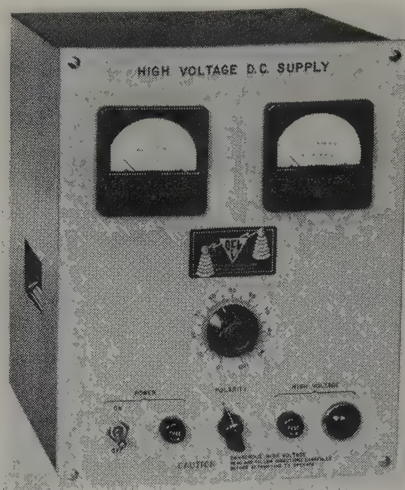
Vibration generators and shaker units are said to provide simpler, more accurate analysis of the effects

of vibration on components and subassemblies. Used in product design and quality control, the generators simulate vibration effects under varying service conditions. They facilitate controlled vibration tests in the laboratory or shop. Six models are available, producing peak thrusts ranging from 2 lbs. up to 18,000 lbs. A complete line of ancillary equipment is also available. Rockbar Corp., 650 Halstead Ave., Mamaroneck, N.Y.

Print No. Ins. 205 on Reader Service Card

Power Supply Rated 30 KV at 3 MA For Insulation Testing, Other Uses

A new compact instrumented power supply rated 30 kv at 3 ma is said to be designed for all commercial and laboratory applications in addition to insulation testing. Model PSC 30-3-4 with an input of 115v 60 cycles has a ripple of 0.5% per ma. It has 10% regulation no load to full load. The transformer and rectifiers are epoxy encapsulated to reduce corona. The



whole unit is contained in a totally enclosed cabinet 9½″ × 11″ × 12″ high, with handles mounted on the sides. It weighs 43 lbs. Outstanding features include reversible polarity. Del Electronics Corp., 521 Homestead Ave., Mount Vernon, N.Y.

Print No. Ins. 206 on Reader Service Card

Safer Processing Ovens

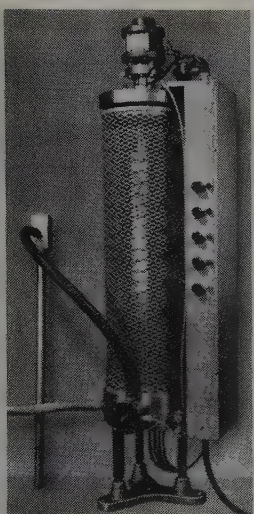
Processing ovens for use up to 260°C have a new safety control system which is said to provide greater safety in hazardous atmospheres and which automatically protects processed material from heat destruction in the event of failure of the master control. If the main control fails, its safety twin takes over and maintains control only a few degrees above the main control. A pilot lamp indicates the change. A limiting control shuts off the oven in the event of flash fire or if its safety setting is bridged.

Other features include a rear blow-out safety panel, automatic pre-ventilation, and enclosed, explosion-proof heaters. Modern Laboratory Equipment Co. Inc., 1809-11 First Ave., New York 28.

Print No. Ins. 207 on Reader Service Card

Degasser for Encapsulating, Coating, and Casting Liquids

New "on-the-fly" degasser is designed to degas liquids used in the production of castings free from voids caused by entrapped gases. This unit

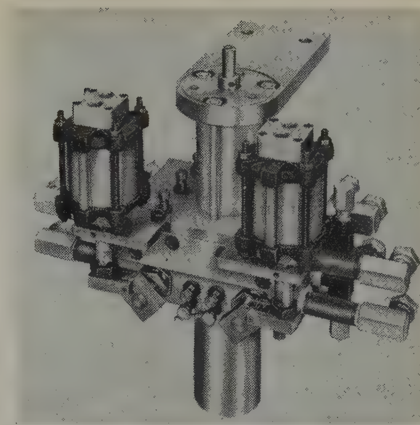


is stated to rapidly remove dissolved or entrapped gasses and other volatile materials from either a continuous or intermittent flow of liquids by means of vacuum and heat. It will handle a broad range of liquid or hot melt materials such as epoxies, urethanes, polyester, vinyl plastisols, waxes, etc., which are used in the production of many types of castings, encapsulations, coatings, etc. Unit consists of a heating and rough degassing section, a film state fine degassing section, and a storage section with a combination output and recirculating pump. All sections are under vacuum and heated. The output pump, driven by a continuously variable speed air motor, feeds the material out as demanded or recirculates it through the system. The system is completely sealed and self-contained, requiring only power (110 or 220 v), air, and vacuum supplies. Automatic Process Control Inc., 1170 Morris Ave., Union, N.J.

Print No. Ins. 208 on Reader Service Card

Large Polyurethane Foam Mixing Heads

Up to six separate foam material



streams can be valved into a new mixing chamber for on-off operation. This recent development is nominally rated at 100 lbs/min and makes possible the pouring of large foam masses on shot-type, production installations. The multiple-component design eliminates the pot life time factor previously encountered when pre-mixing of some ingredients resulted in material loss through chemical deterioration. With proper pumping and metering equipment, mixing head is said to supply accurately proportioned and correctly mixed foam from the very first to the last of a pour.

This is accomplished by fast-acting valving, the interchangeable metering port design, and the self-cleaning, straight-side mixing impeller. Many formulations reportedly can be mixed at rates in excess of 150 lbs/min for molding, pouring-in-place, or slab production of rigid and flexible foams. Bulletin L-236-1 available. The Martin Sweets Co. Inc., 114 S. First St., Louisville 2, Ky.

Print No. Ins. 209 on Reader Service Card

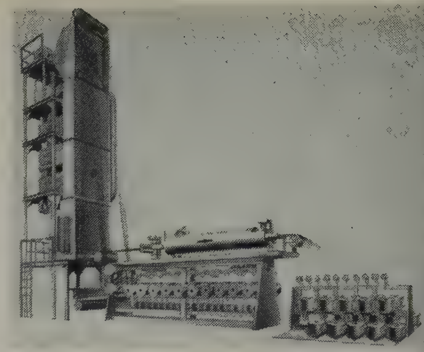
Automatic Cable Tester

New model LA-350 tester is an automatic, tape-programmed instrument designed to test complex cable harness assemblies, cables, wiring, interconnected panels, aircraft and computer wiring installations etc., either before or after they are connected into circuitry. The LA-350 checks continuity and hi-pot, and also measures resistance, voltage, and impedance. All parameters for each test are programmed by punched tape employing a binary coding system. The cable tester consists of a master control unit and one or more modules, using a maximum of 16 modules per module group. Since each module consists of 256 test points, a group of 16 modules yields 4,096 test points. A single control unit drives up to 16 module groups. Therefore, the LA-350 is capable of providing a total of 65,536 test points. The unit features absolute measurement of composite leakage path—one conductor to all other conductors—as well as fault location print-out. It can be equipped to measure d-c and a-c voltages and complex impedances. Lavoie Laboratories Inc., Morganville, N.J.

Print No. Ins. 210 on Reader Service Card

High Production Wire Enameling Equipment

Marked improvements in magnet wire quality and costs are promised by new high production wire enameling equipment. The equipment reportedly applies and cures insulating materials at speeds twice as high as those achieved in conventional equipment of comparable size. Yet the wire produced is said to be of superior quality. A new applicator and die system has been developed which is claimed to allow a more uniform and concentric

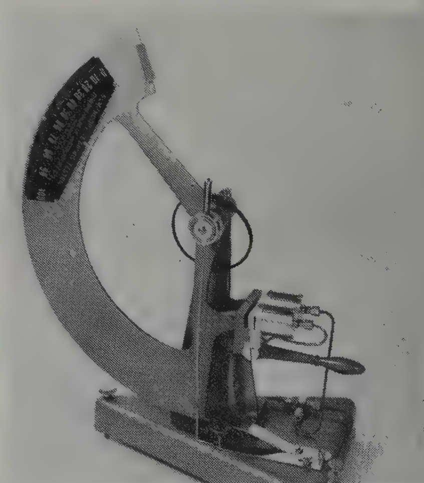


coating of material to be applied to the wire. The oven is arranged so that both heat and convection are closely controlled to vary the zone conditions for solvent evaporation and polymerization. Thus, these two phases of curing proceed at very near maximum theoretical rates. A majority of heat required by the curing process is provided by burning the solvents evaporated from the enamels. This provides economy in operation and eliminates an otherwise difficult fume disposal problem. Industrial Heating Dept., General Electric Co., Shelbyville, Ind.

Print No. Ins. 211 on Reader Service Card

Air Grips for Tearing Tester

New air-operated grips for the Elmendorf tearing tester reportedly enable an operator to test twice as many samples in less time with greatly reduced operator fatigue. Samples can be inserted and removed in one easy



operation without turning any screws. The grips, using air pressures as low as 15 lbs, assure uniform clamping pressure on the sample at all times, and can be installed on existing Elmendorf tearing testers. Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.

Print No. Ins. 212 on Reader Service Card

New Literature

All catalogs, bulletins, and other literature or sample cards described are available free of charge. To obtain your free copies, just print the item number on the Reader Service Card on the back cover. Fill out and mail the card—no postage is required. Insulation *immediately forwards your requests to the companies concerned so that the literature can be sent to you promptly.*

Comprehensive Ceramic Properties Chart

Comprehensive new chart No. 611 lists properties of steatite, forsterite, zircon, titania, titanates, cordierite, lava, alumina, crushable and machine-able ceramics, and other materials. On the back of the wall-size chart, which folds to file size, are several selection tables, each comparing various materials according to one property. Thus, there are separate tables for loss factor, dielectric strength, hardness, flexural strength, thermal expansion, and water absorption. Thermal expansion, dielectric strength, volume resistivity, dielectric constant, and dissipation factor of selected materials are also plotted on graphs. 8 pages. American Lava Corp., subsidiary of Minnesota Mining and Manufacturing Co., Manufacturers Rd., Chattanooga 5, Tenn.

Print No. Ins. 301 on Reader Service Card

Data Sheet on High Temperature Laminate

Technical data sheet covers grade AA-HT heat resistant laminate, an asbestos woven fabric bonded with a high temperature phenolic resin. A general description, forms in which it is available, and typical property values are included. 1 page. Synthane Corp., Oaks, Pa.

Print No. Ins. 302 on Reader Service Card

Epoxy Data Sheets

Data sheets describe two new epoxy systems. Bulletin E-291 covers a liquid epoxy rigid casting compound designed to meet the requirements of MIL-I-16923C, types B, C, and D. Uncured and cured properties, handling and cure data, and availability information are given for the filled system for casting or potting transformers, modules, power supplies, and other components with working temperatures up to 155°C. 3 pages. Bulletin E-309A gives similar details for both a filled and an unfilled medium temperature cure, flexible epoxy system. 4 pages. Hysol Corp., Olean, N. Y.

Print No. Ins. 303 on Reader Service Card

Catalog of Silicone Products, Their Properties and Uses

New catalog describes a complete line of silicones and their uses. Designated CDS-129C, the catalog is liberally illustrated with photos and contains data pertaining to the various silicone products, including a complete selector guide for silicone rubber. The catalog is broken down into four general categories dealing with silicone fluids, silicone protective coatings, silicone electrical insulation, and silicone rubber. Several new products are described. 8 pages. Silicone Products Dept., General Electric Co., Waterford, N. Y.

Print No. Ins. 304 on Reader Service Card

Flexible Class F Tubing And Sleeving Folder

Graphs and tables of electrical, thermal, physical, and chemical characteristics of an isocyanate tubing and sleeving for class F uses are given in new folder No. 61. A packaging and wall thickness chart is also included. 4 pages. Suflex Corp., 33-40 57th St., Woodside 77, L. I., N. Y.

Print No. Ins. 305 on Reader Service Card

Laminated Plastics Catalog

New catalog on industrial laminated plastics in sheet, rod, and tube form covers grade selection and description, range of sizes, typical property values, and forms. There is a special section on metal-clad grades. 20 pages. *Write* Continental-Diamond Fibre Corp., Dept. IN, Newark, Del.

(Continued on page 84)

Two Bulletins on Unusual Polyethylene Applications

Two product bulletins (WC-4-3 and WC-4-4) are titled "Power Cable Insulated with 'Alathon' Polyethylene Resin Selected for San Francisco Bay Bridge Reconstruction," and "New IBM Computer Uses Air Spaced Ribbon Cable Insulated with 'Rulan' Flame Retardant Plastic." The first tells how the electrical properties of Alathon were used in the rewiring of the Golden Gate Bridge lighting system and the second, why Rulan was chosen for IBM's new 7090 Data Processing System. 4 pages each. Polychemicals Dept., E. I. du Pont de Nemours & Co., Wilmington 98, Del.

Print No. Ins. 306 on Reader Service Card

Brochure on Silicone Rubber Coated Fiber Glass Sleeving and Tubing

New brochure describes and lists electrical and other characteristics of SR-398 glass insulating sleeving, a closely woven glass braid annealed to remove organic matter and uniformly coated with silicone rubber. Other silicone rubber products covered include SR-404 fiber glass reinforced silicone rubber sleeving, SR-200 silicone rubber extruded tubing, and silicone rubber insulated wire and cable. 4 pages. L. Frank Markel & Sons, Norristown, Pa.

Print No. Ins. 307 on Reader Service Card

Brochure on Flexible Laminates for Class A and B Uses

Flexible laminates for temperature classes A and B are described in a new brochure. The publication lists standard combinations and typical properties of varnished cambric and polyester film laminations with other materials, including fish, rag, kraft and asbestos papers, and glass fabrics. A description of applications is included, along with a detailed discussion of the common laminating materials offered in duplex and triplex constructions. A new polyester laminate employing a triplex construction to achieve a web/film/web lamination without an adhesive is also described. 8 pages. Dept. W1-193, Irvington Div., Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn.

Print No. Ins. 308 on Reader Service Card

Glass-Bonded Mica Bulletin

Glass-bonded mica substrates and printed circuits are described in a new bulletin. It contains drawings which illustrate fabrication and application of these components as well as graphs and diagrams covering electrical characteristics. Also featured is a property chart detailing general, electrical, and mechanical characteristics of all grades of the glass-bonded mica in standard forms. A listing of sheet prices with available sizes is included along with an information chart on availability of grades which can be obtained from sheet and rod stock, and those which can be machined, molded, electroless copper-coated, and silver-fired. 4 pages. Electronic Mechanics Inc., 101 Clifton Blvd., Clifton, N. J.

Print No. Ins. 309 on Reader Service Card

Folder on Clad Laminated Plastics Conforming to Military Specs

Revised standards for copper-clad laminated plastics conforming to the latest issue of MIL-P-13949B are included in an up-dated brochure. It contains data on 10 copper-clad grades most useful for printed or etched circuits, including four of the latest—these are a flame-retardant phenolic/paper-base laminate, a paper-filled laminate with an epoxy resin binder, a similar laminate with flame-retardant properties, and a glass-base/epoxy resin laminate which is also flame-retardant. Other grades are discussed, including paper-base and woven glass fabric-base laminates. Synthane Corp., Oaks, Pa.

Print No. Ins. 310 on Reader Service Card

Catalog of Ceramic Products And Production Facilities

New catalog on steatite and allied ceramic materials lists mechanical and electrical properties of each, and describes and illustrates production processes, facilities, and finished ceramic parts. 16 pages. Du-Co Ceramics Co., 470 Main St., Saxonburg, Pa.

Print No. Ins. 311 on Reader Service Card

Properties Chart of Epoxy Electrical Insulating Materials

Resilient epoxy resins which are said to possess not only the capacity for good thermal shock resistance, but also excellent electrical properties at both low and high temperatures, are covered in a new properties chart. Complete analyses are presented of electrical as well as of mechanical properties of epoxy electrical insulating materials. Featured are amine and anhydride curing agents. Data on losses in weight on prolonged high temperature exposure are included. 6 pages. Furane Plastics Inc., 4516 Brazil St., Los Angeles 39.

Print No. Ins. 312 on Reader Service Card

Booklet on Merits, Uses, and Properties of Cellulosic Plastics

A concise description of the properties of "Tenite" cellulosic plastics and their application in commercial and industrial products is presented in a new illustrated pamphlet. Dealing specifically with acetate, butyrate, and propionate, the pamphlet summarizes and compares the basic characteristics of these plastics and discusses their versatility in terms of range and scope of usage. Informative and to the point, the publication has practical introductory reference value. Eastman Chemical Products Inc., Kingsport, Tenn.

Print No. Ins. 313 on Reader Service Card

Folder on Sources of Supply For Polycarbonate Resin Shapes

New folder lists sources of supply for "Lexan" polycarbonate resin in standard fabricated shapes. Designated CDC-389, the folder lists fabricators and the sizes of rod, sheet, tube, film, and slab available. The booklet also contains a description of 14 properties of the resin, and data about its use. 4 pages. Chemical Materials Dept., General Electric Co., Pittsfield, Mass.

Print No. Ins. 314 on Reader Service Card

Data Sheet on Silico-Ceramic Electrical Insulating Compound

New data sheet covers silico-ceramic high temperature sealing, insulating, potting, and encapsulating material. Electrical insulating applications, material characteristics, and specifications and technical property data for several formulations are given. 2 pages. Physical Sciences Corp., 389 N. Fair Oaks Ave., Pasa-

lena, Calif.

rint No. Ins. 315 on Reader Service Card

lastics Properties Chart

Brochure contains an unusual chart f the properties of thermoplastic and hermosetting plastics and of high-ressure laminates. The name of the naterial is listed along the left-hand dge of the chart and all relevant harteristics are listed across the top. This layout is said to be the most ogical one in terms of the engineer's r buyer's interest. 16 pages. Comnercial Plastics & Supply Corp., 630 Broadway, New York 12.

rint No. Ins. 316 on Reader Service Card

ystems Selector for Epoxy Insulation

A new electrical insulation systems elector shows the outstanding properties of selected epoxy insulating ompounds. It contains helpful data n insulation selection, and charts andling characteristics and physical nd electrical properties of general urpose casting and potting compounds, compression and transfer nolding powders, dipping compounds, and conductive cements and coatings. It will fit file drawer or notebook and also folds open to make an easy reference wall chart. 6 pages. Electrical Insulation Div., Hysol Corp., Olean, N. Y.

Print No. Ins. 317 on Reader Service Card

Area Converter for Plastics Sheets

Square foot conversion for plastic sheets up to 67″ x 102″ are said to be made easy by a "three-in-one" handy pocket-size reference book which is being reissued. It gives the decimal equivalents involved, and sheet, rod, and tube diameters and thicknesses. Booklet measures only 4″ x 7″. The two-way tables have been conveniently sectionalized by area size in order to limit the need for turning pages. Dimensions are readily visible; black numbers have been printed against a yellow background so they are clearly and neatly outlined. A handy ruler for sheet, rod, and tube diameters and thicknesses runs along the left-hand edge of the back cover. Commercial Plastics & Supply Corp., 630 Broadway, New York 12.

Print No. Ins. 318 on Reader Service Card

Narrow Fabrics Standards Pamphlet

New standards pamphlet, entitled "Woven Nonelastic Narrow Fabrics: Classification—Nomenclature—Definitions," is intended to improve buyer and seller relations by promoting the use of a common language among the narrow fabrics trade. It contains a classified and alphabetical list of narrow fabrics by end use applications and recommended standard definitions of the narrow fabrics industry, as well as of woven nonelastic tape and webbing. 8 pages. Narrow Fabrics Institute Inc., 11 West 42nd St., New York 36.

Print No. Ins. 319 on Reader Service Card

Booklet Describes Etch Resist For Printed Circuits

Properties and advantages of a screen resist for printed circuits—which is said to positively block off unwanted electroplate and permit pattern lines .005″ wide, .005″ apart—are described in a new technical booklet. Applications and properties are summarized and other details are given. 5 pages. The Meaker Co., sub-

sidiary of Sel-Rex Corp., 75 River Rd., Nutley 10, N. J.
Print No. Ins. 320 on Reader Service Card

Folder on Contract Research

New folder on the procedures and characteristics of contract research for industry describes the balance of administrative controls between the sponsor of a project and the research institute engaged to conduct the study. It covers such topics as objectives, scope, costs, and timing of research. 4 pages. Publications Office, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio.
Print No. Ins. 321 on Reader Service Card

Brochure on New Ceramic Metalizing Facilities

Brochure introduces a new ceramic-metallizing firm with facilities especially designed and constructed for the production of high temperature ceramic-to-metal products. Production capabilities, processing methods, contamination-free manufacture, testing procedures, and personnel are described in detail. Also outlined are characteristics and quality standards of basic products such as terminal insulators and ceramic-to-metal seals. 8 pages. Ceramics International Corp., 39 Siding Place, Mahwah, N. J.
Print No. Ins. 322 on Reader Service Card

Bulletin on Instruments for Testing Insulation or Insulated Components

Special instrument arrays for automated testing of large lots of electrical and electronic components, cable conductors, and insulating material samples are described in new Advance Engineering Data Bulletin 8-70.1. It covers: a-c and d-c high voltage breakdown testing, insulation resistance measurement, leakage current measurement, continuity tests, and capacity and resistance bridges, automatic and servo operated. 4 pages. Associated Research Inc., 3777 W. Belmont Ave., Chicago 18.
Print No. Ins. 323 on Reader Service Card

Brochure Defines Functions Of Research Laboratory

The increasingly vital role of the research laboratory in the growth of an electrical/electronic equipment and components manufacturing corporation is graphically described in a new illustrated brochure. The brochure details the activities of research laboratories in the development of a product, in product testing and inspection standards and procedures, in contributing to "Creative Approach" surveys on individual customer's needs, and in "research for tomorrow." AMP Inc., Harrisburg, Pa.
Print No. Ins. 324 on Reader Service Card

Catalog of Electronic Wire, Cable, and Tubing

New catalog No. 62 gives complete details on more than 6000 electronic wire, cable, and tubing stock products, and introduces 8 new wire and tubing lines. The catalog is indexed alphabetically, numerically, and by government and industrial specification. It also has an "E-Z" index chart with which any catalog item may be located by number of conductors, wire size, and whether it is shielded or unshielded. 52 pages. Alpha Wire Corp., 200 Varick St., New York 14.
Print No. Ins. 325 on Reader Service Card

Bulletin on Cable Constructions

Two compact technical bulletins define typical constructions of transmission line, rotor, and high voltage cables. Bulletin #34 is on transmission line and rotor cables; #35 is on high voltage cables. Phalo Plastics Corp., 530 Boston Turnpike, Shrewsbury, Mass.
Print No. Ins. 326 on Reader Service Card

Data Sheet on Coils with More Ampere Turns

Data sheet gives detailed information on coils with more ampere turns, and a comparison chart for plotting curves of wire size and turns per square inch of window area of other coils against those coils. New bobbin design, degassing, and stress-relieving are featured. 2 pages. Tur-Bo Jet Products Co. Inc., 424 S. San Gabriel Blvd., San Gabriel, Calif.
Print No. Ins. 327 on Reader Service Card

Reference Manual on Butyl-Insulated Cable

Latest information on cables insulated with a butyl-base high voltage insulation is available in a new reference manual. Cable constructions, service records, outstanding characteristics, electrical properties, quality control, and many applications are discussed and illustrated. Data on current carrying capacities, dimensions, and the various designs available are given. 48 pages. The Okonite Co., Passaic, N. J.
Print No. Ins. 328 on Reader Service Card

Bulletin Describes Dispensers For Pre-Cut Wire

Faster wiring of harnesses, control panels, and electronic assemblies is said to be possible with the wire dispenser described in new bulletin 360. Advantages and engineering data are given for the plastic containers which take bulk loaded wire lengths that are withdrawn one at a time. 2 pages. Products for Industry Inc., 1704 Summer St., Stamford, Conn.
Print No. Ins. 329 on Reader Service Card

Cable Product Bulletin

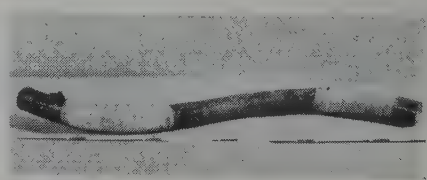
New product bulletin #133 contains detailed product and technical data on cable constructions typically used in inter-communicating, sound system, public address, and related applications. Cable constructions for these uses are grouped as follows: cabled, shielded, jacketed 2-7 conductors; twisted pairs, cabled, jacketed 1-27 pairs; cabled, jacketed 2-9 conductors; twisted pairs and triples; and miscellaneous constructions. 12 pages. Phalo Plastics Corp., 530 Boston Turnpike, Shrewsbury, Mass.
Print No. Ins. 330 on Reader Service Card

Catalog Supplement on Cord Sets

Bulletin No. 37 supplements cord set section in a general product catalog regarding cord sets, packaging alternatives, and U.L. label procedures. Phalo Plastics Corp., 530 Boston Turnpike, Shrewsbury, Mass.
Print No. Ins. 331 on Reader Service Card

Cable Sheath Repair Literature

A method for making sheath crack repairs on lead cable is discussed in new literature. Details are also given on the use of a cable accessory kit for use in the repair of cracked lead cable sheaths. The Epoxylite Corp., 1428



North Tyler, South El Monte, Calif.
Print No. Ins. 332 on Reader Service Card

Bulletin on Cable Reels

The "Reel" story illustrates and describes a varied and wide line of industrial reels ranging in size from 1½ lbs to others weighing several hundred pounds capable of retracting up to one mile of cable. 4 pages. Aero-Motive Mfg. Co., 1803 Alcott St., Kalamazoo, Mich.
Print No. Ins. 333 on Reader Service Card

Bulletin on Insulation Testers

New bulletin 21-45-93 illustrates and describes new and improved "Meg" type insulation testers. These instruments are in the 500 and 1000 v class with sensitivities up to 10,000 megohms in the 1000-v models. Hand-operated, rectifier-operated, dual-operated, and two-voltage instruments are covered. A price list is included. 14 pages. James G. Biddle Co., 1316 Arch St., Philadelphia 7.
Print No. Ins. 334 on Reader Service Card

Condensed Catalog of Instruments, Silico-Ceramic Insulation, And Magnet Wire and Cable

Condensed catalog FP-1-61 of high reliability instruments and components also gives a brief account of the company and manufacturing facilities. Included among the products described are electrical connectors and headers, silico-ceramic high temperature-radiation resistant insulation material for potting and encapsulating uses, insulated magnet wire and cable, and many scientific instruments. 4 pages. Physical Sciences Corp., affiliate of Packard Bell Electronics, 389 North Fair Oaks, Pasadena, Calif.
Print No. Ins. 335 on Reader Service Card

Mechanical Convection Ovens Bulletin

Bulletin No. 1960 illustrates and describes a new line of mechanical convection ovens, such as laboratory/production ovens, aging ovens, miniature batch ovens, hazard-safe ovens, five-drawer ovens, environmental cabinets, conditioning cabinets, and refrigerated baths, as well as a detailed explanation of the Power-O-Matic 60 control system. 12 pages. Blue M Electric Co., 138th and Chatham St., Blue Island, Ill.
Print No. Ins. 336 on Reader Service Card

Heating Rack Bulletin

Bulletin 103-T describes a new series of "Folded and Formed" industrial electric heating units (to 1850°F) for furnaces, ovens, and dryers. Included are sections on application, performance, dimensional specifications, and installation, as well as numerous charts and tables. 16 pages. Trent Inc., 211 Leverington Ave., Philadelphia 27, Pa.
Print No. Ins. 337 on Reader Service Card

Brochure on Plating Equipment And Corrosion Test Cabinets

Many new developments for platers are displayed in illustrated Bulletin S-1-61. It highlights a variety of high-performance original and replacement plating cylinders, superstructures, tanks, and components. "See-in" corrosion test cabinets of lined stainless, lined steel, and H-T Plexiglas with recessed control panels and other improvements for close tolerance testing of materials and finishes are also shown. 4 pages. The Singleton Co., 11770 Berea Rd., Building B, Cleveland 11, Ohio.
Print No. Ins. 338 on Reader Service Card

Dates to Circle

Meeting and Convention Notices

June 3-6 . . . NEMA, Insulating Materials Division Annual Meeting, The Homestead, Hot Springs, Va.

June 5-7 . . . Edison Electric Institute, Annual Convention, Waldorf-Astoria Hotel, New York City.

June 5-7 . . . American Society for Quality Control, Annual Convention and Exhibition, Sheraton Hotel, Philadelphia, Pa.

June 5-9 . . . SPI, Annual National Plastics Conference and Exposition, Commodore Hotel and the Coliseum, New York City.

June 6-8 . . . Instrument Society of America, Summer Instrument-Automation Conference and Exhibit, Royal York Hotel and Queen Elizabeth Hall, Toronto, Canada.

June 8-9 . . . NEMA, Western Conference, The Biltmore Hotel, Los Angeles.

June 8-10 . . . Manufacturing Chemists' Association, Inc., Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.

June 11-14 . . EASA, Annual Convention, Jack Tar Hotel, San Francisco, Cal.

June 11-15 . . . American Society of Mechanical Engineers, Semiannual Meeting, Statler-Hilton Hotel, Los Angeles, Cal.

June 13-16 . . . Institute of Aerospace Sciences and American Rocket Society, Hotel Ambassador, Los Angeles.

June 18-23 . . . AIEE, Summer General Meeting, Cornell University, Ithaca, N. Y.

June 19-22 . . . American Electroplaters' Society, 48th Annual Convention, Statler-Hilton Hotel, Boston, Mass.

June 19-24 . . . American Assn. for the Advancement of Science, Pacific Division Meeting, University of California, Davis, Calif.

June 21 . . . AIEE, Education in Electrical Education, co-sponsored by the Electrical Insulation and Education committees, Cornell University, Ithaca, N.Y.

June 21-July 1 . . . International Plastics Exhibition and Convention, Olympia, London, England. Address inquiries to: Interplas '61, Dorset House, Stanford St., London S.E. 1, England

June 22-23 . . . The Wire Association, West Coast Regional Meeting, Jack Tar Hotel, San Francisco.

June 25-30 . . . ASTM, 64th Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 26-28 . . . IRE, National Convention on Military Electronics, sponsored by Professional Group on Military Electronics, Shoreham Hotel, Washington, D.C.

June 26-28 . . . 68th Annual Meeting, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Statler-Hilton Hotel, Denver, Colo.

June 26-30 . . . AIEE, Aero-Space Transportation Conference, Benjamin Franklin Hotel, Philadelphia, Pa.

June 26-30 . . . Western Summer Radio-Television and Appliance Market (Division of Western Home Goods Market), Western Merchandise Mart, San Francisco, Cal.

June 26-30 . . . American Society for Engineering Education, Annual Meeting, University of Kentucky, Lexington, Ky.

June 28-30 . . . Joint Automatic Control Conference, sponsored by AIEE, ASME, IRE, Instrument Society of America, and American Institute of Chemical Engineers, University of Colorado, Boulder, Colo.

June 29 . . . High Precision Connectors, National Bureau of Standards, Boulder Laboratories, Boulder, Colo.

July 18-20 . . . Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles.

July 27-Aug. 1 . . . International Symposium on Macromolecular Chemistry, Montreal, Canada. Address inquiries to: The Organizing Committee, International Symposium on Macromolecular Chemistry, P. O. Box 816, Sarnia, Ontario, Canada.

Aug. 22-25 . . . WESCON, The Cow Palace, San Francisco.

Aug. 23-25 . . . AIEE, Pacific General Meeting, Hotel Utah, Salt Lake City, Utah.

Sept. 12 . . . SPE, Plastics for Tooling, Retec sponsored by Central Indiana Section, Hotel Severin, Indianapolis, Ind.

Sept. 14-15 . . . Engineering Management Conference, AIEE and ASME, Hotel Roosevelt, New York City.

Sept. 24-29 . . . Illuminating Engineering Society, National Technical Conference, Chase Park Plaza Hotel, St. Louis, Mo.

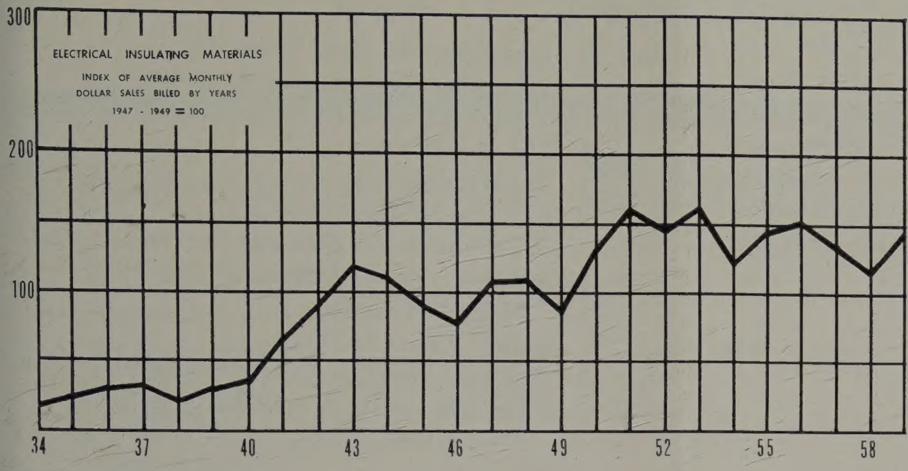
Oct. 9-11 . . . National Electronics Conference, sponsored by AIEE, IRE, Illinois Institute of Technology, Northwestern University, and the University of Illinois, Hotel Sherman, Chicago.

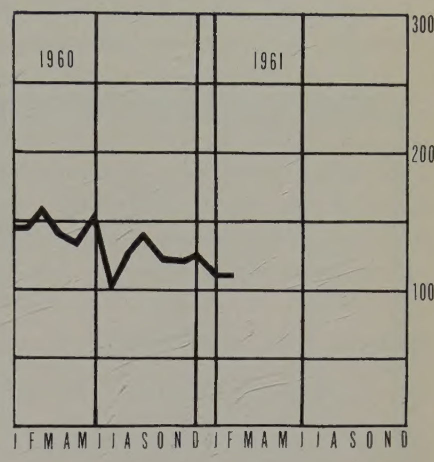
Oct. 23-25 . . . Conference on Electrical Insulation, National Academy of Sciences —National Research Council, Pocono Manor Inn, Pocono Manor, Pa.

Abbreviations Used in Notices

AIEE —American Institute of Electrical Engineers
ASTM —American Society for Testing Materials
ASME —American Society of Mechanical Engineers
ASA —American Standards Assn.
IRE —Institute of Radio Engineers
EIA —Electronic Industries Assn.
NEMA —National Electrical Manufacturers Assn.
EASA —Electrical Apparatus Service Assn.
SPE —Society of Plastics Engineers
SPI —Society of the Plastics Industry
WEMA —Western Electronic Manufacturers Assn.

NEMA Electrical Insulation Index





	Feb. '61	Jan. '61	Feb. '60
Index Series	118	118	149
Feb. '61 point change from other mos.		0	—31
Feb. '61 % change from other months		0	—21

Index is based on 1947-1949 average month, inclusive= 100

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Glass/Polyester GPO-1 (Typical Industry Values)	1.0	23,900	10,750*	8	100	19*	$1.00
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